training of mathematics teachers in republic of south africa and in some western countries

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THE TRAINING OF MATHEMATICS TEACHERS IN THE REPUBLIC OF SOUTH AFRICA AND IN SOME WESTERN COUNTRIES

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P R E F A C E

At the request of the Mathematics Association of South Africa the Institute for Educational Research of the Human Sciences Research Council launched a comprehensive research programme covering numerous aspects of the teaching of Mathematics in the RSA at primary and secondary school level. Two reports resulting from this research programme have already been pu= blished, viz The Aims of Mathematical Instruction and the Problems in Connection with Innovation in respect of the Teaching of this subject in South Africa and The Instruction of Mathe= matics at Secondary School Level in a number of Countries in Western Europe (Reports O-13 and O-29, Institute for Educational Research, HSRC, Pretoria).

This report on the training of Mathematics teachers describes the position as it was in July 1974. It is the third in the series and concerns the training of both primary and secondary school Mathematics teachers in the RSA. Since the report con= tains a wealth of information the ad hoc committee which approved the report wisely decided that a concise version of the report should be prepared in which the main findings and the recommendations should receive the necessary emphasis and attention. The concise version, entitled Aspects of the Training of Primary and Secondary Mathematics Teachers in the Republic of South Africa, is available under separate cover.

I wish to express my sincere gratitude to members of the ad hoc committee who sacrificed their time in order to attend the meetings and to evaluate the report. It is hoped that this report will contribute towards the progress already evident in the training of Mathematics teachers under the new Education Policy Amendment Act (Act No. 73 of 1969).

A. L. Kotzee

PRESIDENT

1976

C O N T E N T S

TABLE | PAGE

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O P S O M M I N G

In 1969 is die Nasionale Onderwys Wysigingswet (Wet No. 73 van 1969) deur die parlement van die Republiek van Suid-Afrika op die wetboek geplaas. Die belangrikste bepaling van hierdie Wet is dat alle opleiding van onderwysers vir die sekondêre skool voortaan alleenlik deur die universiteite behartig mag word. Hierdie bepaling het onder meer 'n skielike toevloei van studente na die Fakulteite van Opvoedkunde aan die onderskeie universiteite veroorsaak. Die doel met hierdie navorsing was om sover doenlik die nuwe onderwysersopleidingkursusse in Wiskunde wat volgens hierdie bedeling ingestel is, te evalueer en om aanbevelings te doen ter oorbrugging van probleme wat mag ontstaan het.

Ondersoek is ingestel na die vermeende tekort aan Wiskunde-onderwysers. Dit het geblyk dat daar wel 'n tekort ontstaan het en dat dit kommerwekkend is. In 1971, byvoorbeeld, het 30,6 persent van alle Wiskunde-onderwysers aan sekondêre skole nie voldoen aan die minimum wetlike kwalifikasies wat betref hul akademiese of professionele opleiding nie. In 1972 het hierdie persentasie na 31,4 opgeskuif. Bo en behalwe hierdie onder=wysers, is bevind dat in 1971 'n verdere 16,7 persent wat wel ten opsigte van ander vakke aan die minimum vereistes voldoen het, Wiskunde onderrig het, alhoewel hulle nie voldoende daar=voor opgelei was nie. In 1972 het laasgenoemde persentasie tot 17,9 gestyg. Indien hierdie persentasies saamgevoeg word, blyk dat, in 1971, 47,3 persent van die onderwysers wat onderrig in Wiskunde gegee het, nie oor die nodige kwalifikasies in dié vak beskik het nie, terwyl dié persentasie in 1972 tot 49,3 gestyg het.

Dit blyk verder uit die ondersoek dat Engels, Rekenkunde, Afrikaans en Wiskunde dié akademiese vakke is ten aansien waar=van die grootste persentasie tydelike onderwysers in 1971 aan=getref is en wel respektiewelik 33,8; 27,9; 27,6 en 25,6. Hierdie persentasies dui op 'n hoë mate van personeelonstabili=teit, veral as in gedagte gehou word dat dit hoofsaaklik die tydelike personeel is wat vir die wisseling van personeel in die skole verantwoordelik is.

Die verbetering van diensvoorwaardes asook salarisverhogings wat gedurende die afgelope aantal jare toegestaan is, blyk ook nie baie suksesvol te wees om manlike onderwysers na die onderwysberoep te lok en daarin te behou nie. Gedurende die jare 1967 tot 1971 het die verhouding manlike personeel teenoor vroulike personeel van 1,4 : 1 tot 1,09 : 1 afgeneem.

Met die oog daarop om die opleiding van Wiskunde-onderwysers in die RSA te evalueer, is 'n studie van die opleiding van soort=gelyke onderwysers in 'n paar geselekteerde oorsese Westerse lande onderneem. In die Verenigde State van Amerika en die Verenigde Koninkryk word gepoog om die status van die onderwys=professie te verhoog deur graadstatus toe te ken aan onderwysers=opleidingkursusse wat voorheen diplomakursusse was. Die diplomakursusse word wel uitgebrei en verleng om in 'n mate hul graadstatus te regverdig. Op talle terreine van die opleiding van onderwysers vind vernuwing plaas wat ook van waarde vir die Wiskunde-onderwyser blyk te wees. In België, Nederland en Wes-Duitsland is institute gestig met die uitsluitlike doel om navorsing te onderneem ten aansien van die didaktiese aspekte van Wiskunde. Voorts word daar in die Verenigde State van Amerika daarna gestreef om by wyse van die ontwerp van die mikro-onderwystegniek vernuwing in die professionele opleiding van die onderwyser te bewerkstellig.

Hierdie navorsingsprojek het aan die lig gebring dat naas prysenswaardige kenmerke van die opleiding van Wiskunde-onder=wysers hier te lande, daar nogtans twee belangrike tekortkominge ontstaan het: As gevolg van die afwesigheid van enige toe=latingsvereistes ten opsigte van Wiskunde vir voornemende primêre skool-onderwysers, word tans 'n onwenslike situasie aan alle onderwysersopleidingsinrigtings aangetref wat die verpligte Wiskundemetodiekkursusse aanbied. Aangesien die Wiskunde=metodiekkursusse verpligtend is, word 'n heterogene groep studente in dié klasse aangetref, waarvan ongeveer dertig persent Wiskunde op standerd ses-vlak geslaag het, ongeveer veertig persent op standerd agt- of negevlak en die oorblywende dertig persent op standerd tien-vlak. Dosente is derhalwe verplig om "revision of the students' own mathematical knowledge to a level roughly equivalent to Std 7" te doen. Hierdie onbevredigende peil van onderwyseropleiding kan heel waarskynlik daartoe lei dat die onbevoegde onderwyser alle belangstelling in Wiskunde by die leerlinge sal smoor.

Wat betref die opleiding van Wiskunde-onderwysers vir die
sekondêre skool, is daar bevind dat 'n behoefte bestaan aan
akademiese Wiskundekursusse wat spesifiek meer onderwysgerig
is. Belangrik egter is dat hierdie onderwysgeoriënteerde
Wiskundekursusse deur die universiteite vir graaddoeleindes
erken moet word, al is dit slegs gedeeltelik volgens 'n krediet=
sisteem. In hierdie verband hou die "modulesisteem" wat deur
die Fakulteit Natuurwetenskappe van die Universiteit van
Suid-Afrika ingestel is, groot moontlikhede in.

Ter bevordering en uitbouing van die onderrig van Wiskunde is
aanbevelings gedoen met betrekking tot die opleiding van
Wiskunde-onderwysers vir sowel die primêre as die sekondêre
skool.

S U M M A R Y

In 1969 the National Education Policy Amendment Act No. 73 was passed by the Parliament of the Republic of South Africa. The most important provision of this Act stipulated that all secon= dary school teacher training should in future be the sole re= sponsibility of the universities. This provision resulted in a sudden channelling of students to the Education Faculties of the universities. The aim of this report was to evaluate as far as was possible the new teacher training courses in Mathematics that came into existence according to this ruling and to offer recommendations for correcting shortcomings that may have arisen as a result of the change in direction brought about by the Act.

A study was made of the presumed shortage of Mathematics Teachers. It transpired that a shortage did exist and this was certainly cause for grave concern. In 1971, for example, 30,6 per cent of all secondary school Mathematics Teachers in the RSA did not satisfy the minimum academic or professional qualification re= quirements as laid down in legislation. In 1972 this percentage rose to 31,4. Apart from these teachers, a further 16,7 per cent of the teachers who were suitably qualified in subjects other than Mathematics, were teaching the subject in 1971 although they were not satisfactorily qualified to do so. This percentage rose to 17,9 in 1972. If these percentages are considered to= gether, it becomes evident that, in 1971, 47,3 per cent of the teachers teaching Mathematics at secondary school level were not sufficiently qualified to teach the subject, and in 1972 this percentage rose to 49,3. At the same time it transpires that English, Arithmetic, Afrikaans and Mathematics are the academic subjects with the greatest percentage of temporarily appointed teachers, viz 33,8; 27,9; 27,6 and 25,6 respectively in 1971. The latter figures indicate an increasing degree of staff instability in the schools as it is largely the temporarily appointed teachers who are responsible for the turnover of staff.

Moreover, salary increases and the improvement of conditions of service do not seem to have been an incentive to attract male teachers to the teaching profession and to keep them there. The male - female ratio decreased from 1,4 : 1 in 1967 to 1,09 : 1 in 1971.

In order to assess the training of Mathematics teachers in the RSA a study of the training of Mathematics teachers in a selection of Western countries was undertaken. In the United States of America and the United Kingdom especially, the trend is to enhance the status of the teaching profession by granting degree status to teacher training courses which were formerly diploma courses. The courses are reorganised and extended to justify their degree status to some extent. Many innovations are taking place in the field of teacher training and are proving to be of value to Mathematics teachers as well. In Belgium, the Netherlands and West-Germany institutes have been established with the sole purpose of doing research into the didactical aspects of Mathematics, while in the United States of America impetus has been given to the system of teaching practice through the development of the micro-teaching method.

This study found that among the predominantly commendable features of the training of Mathematics teachers in the RSA, two main shortcomings existed: As regards the training of Mathe= matics teachers for the primary school it was found that, owing to a complete lack of admission requirements in respect of Mathematics, a most unhealthy situation has developed in the Mathematics Method Courses offered by the various institutions. Since the Mathematics Method Courses are compulsory it happens that a heterogeneous group of students are found in these classes, of whom, on an average, thirty per cent have only Std. 6 Mathematics to their credit, forty per cent Std. 8 and the remaining thirty per cent Std. 10. Lecturers are then compelled to do "revision of the students' own mathematical knowledge to a level roughly equivalent to Std 7". This level of teacher training can only result in a standard of teaching in primary school Mathematics that stifles pupils' interest in and talent for the subject.

As far as the training of Mathematics teachers for the secondary school is concerned, it was found that there was a need for academic Mathematics courses devised specifically for the professional diplomas but which would also be recognised by the universities for degree purposes, if only in part according to a credit system. In this respect the recent introduction of a "module" system by the Faculty of Science of the University of South Africa augurs well for the future.

Recommendations aimed at improving the teaching of Mathematics in the schools have been made in respect of the training of Mathematics teachers for both the primary and the secondary school.

CHAPTER 1

INTRODUCTORY REMARKS IN CONNECTION WITH THE TRAINING OF MATHEMATICS TEACHERS IN THE REPUBLIC OF SOUTH AFRICA

1.1 THE EVENTS LEADING TO THE LAUNCHING OF THE MATHEMATICS PROJECT

This report is one of a series of reports covering the teaching of Mathematics in the Republic of South Africa and is as such part of an extensive research programme. The Human Sciences Research Council instituted this research programme in Decem= ber 1970 at the request of the Mathematics Association of South Africa (MASA). MASA had arranged a congress in Pretoria in April of the same year to discuss the teaching of Mathematics in South Africa. At this congress, which was attended by Mathematics teachers, university lecturers and other interested persons from all over South Africa, it was decided to launch a project aimed at the improvement and reform of Mathematics teaching. This project was officially called the South African Mathematics Project (SAMP) and is the joint responsibility of MASA and the Foundation for Education, Science and Technology. The following excerpt from the minutes of the April Congress is significant: "It is suggested that the first phase of the project (SAMP) should consist of research by the Human Sciences Research Council in conjunction with the Foundation for Educa= tion, Science and Technology and the Mathematical Association, covering the following points:

a. The study of the functioning and results of school Mathe= matics projects in other countries with special reference to -

   methods of examination;
   methods of providing new text books;
   the training and retraining of teachers;
   principles and norms by which existing subject-matter was eliminated and new matter introduced.

b. Recommendations with respect to paragraph (a) and how to implement renewal in the context of South African circum= stances."

The above request was made to the Human Sciences Research Coun= cil (HSRC) shortly afterwards and in June 1970 the HSRC agreed to undertake a research programme along the lines of the request. The following month, July 1970, at a committee meeting of the SAMP held in Pietermaritzburg, it was decided to request the HSRC to extent its research programme to the teaching of Mathe= matics at primary school level as well. This request the HSRC subsequently acceded to in December 1970.

1.2 THE AIM OF THIS PROJECT

The aim of the whole research programme and of this particular study is to contribute to the improvement of the teaching of Mathematics in the Republic of South Africa. In planning the research programme it was considered essential to direct the initial research along such lines so as to find answers to the following questions:

a. What are the aims of Mathematics teaching?

b. Is there scope for the "renewal" of Mathematics and Mathe= matics teaching in South Africa?

c. In what way can research contribute to the "renewal" of the teaching of Mathematics and which aspects are relevant?

d. What is the current position as regards the "renewal" of Mathematics and of Mathematics teaching in Western coun= tries?

In order to find answers to the above questions a study was made of the aims of the teaching of Mathematics. This study has already been completed and was published recently under the following title: Die Doelstellings met Wiskundeonderrig en die Problematiek verbonde aan vernuwing ten opsigte van Wiskunde= onderrig in Suid-Afrika (Project O-13, 1972).

This above-mentioned study came to the conclusion that there is indeed room for "renewal" and "improvement" as far as the teaching of Mathematics is concerned and that research can most certainly play an important role in achieving this. In para= graph 7.5 of the report it is emphasized that research into the initial training and inservice training of Mathematics teachers could make a direct contribution to the improvement of the teaching of Mathematics in this country. This report therefore is an attempt to give a review of the present state of the training of Mathematics teachers. Initially a study of all the available literature in connection with the training of teachers of Mathematics in America, England, the Netherlands, Belgium and Western Germany was undertaken as a background for research into the South African situation. The results of this inves= tigation are to be found in Chapter 5 of this report.

1.3 PREVIOUS RESEARCH IN CONNECTION WITH THE TEACHING OF MATHEMATICS IN THE REPUBLIC OF SOUTH AFRICA

Research in connection with the teaching of Mathematics in South Africa has been done before by various persons. The first of these research programmes was completed in 1942 by Dr A.J. van Zyl, at present Director of the Pretoria College for Advanced Technical Education. His report was published under the title Mathematics at the Cross-roads. The Transvaal Education Department launched an important research programme into the possibility of renewal in several subjects and the findings of this research programme were published in 1964. The Mathematics report, written by this mission, has been the blueprint for the planning of Mathematics teaching in the Transvaal schools since then.

At the request of the Mathematics Association of South Africa the National Bureau for Educational and Social Research under= took another research project in connection with the teaching of Mathematics. This project was completed in 1965 by Dr A.J. van Rooy and published under the title The Teaching of Mathematics, General Mathematics and Arithmetic. In his report Dr van Rooy made several very important recommendations, the most important for this research project being that the drastic shortage of competent and well-qualified Mathematics teachers urgently required investigation. The present research programme as requested by the Mathematics Association of South Africa can therefore be seen as a direct result of the recommen= dations made by Dr van Rooy in his report.

1.4 THE NECESSITY OF RESEARCH IN RESPECT OF THE TRAINING OF MATHEMATICS TEACHERS IN THE REPUBLIC OF SOUTH AFRICA

1.4.1 General

Research overseas and especially in Britain and continental Europe has revealed that presenting Mathematics "with a dead, depressing finality as a finished, closed structure" does not motivate pupils or inculcate a love for Mathematics in them while "an intuitive, heuristic approach, based on the mathema= tization of situations" could be much more meaningful and enduring for the pupils (13, p. 3). For a short historical review of the events which gave rise to tremendous interest and renewal in Mathematics teaching since 1958, see the report entitled Die Doelstellings met Wiskundeonderrig en die Proble= matiek verbonde aan vernuwing ten opsigte van Wiskundeonderrig in Suid-Afrika (Project O -13 by P.G. Human). Possibly one of the greatest shortcomings of Mathematics teachers is that they do not realise what sense and meaning Mathematics can and should have for their pupils and consequently the teaching of Mathe= matics has degenerated to the mere reproduction of so many tricks. Insight into the aims of the teaching of Mathematics is therefore absolutely necessary. A report published in the United States of America in 1959 emphasized that over and above courses in the Philosophy of Education and Psychology of Educa= tion there was a great need for a course which dealt specifi= cally with the teaching of Mathematics (6, p. 57). The report further pointed out that where teacher training courses in Mathematics were presented in the form of recipes without regard for the structure of Mathematics and without attempting to awaken the interest of the students, it could be taken for granted that these students would similarly present their Mathe= matics lessons to the pupils in a dull and uninspiring way (6, p. 54).

W.W. Sawyer, the well-known writer of popular Mathematics textbooks maintains that the present courses in Mathematics (which are taken by prospective teachers too) fail to show the connection between different mathematical topics or their place within the greater framework of this subject as a whole. Topics are usually presented as loose units whereas attention should be given to present the topics in such a way that they form a logical whole (38, p. 220). Prospective secondary school Mathematics teachers especially should, for instance, see how Cantor's work on sets came about as a result of his study of the Fourier series, how Hilbert's study of spaces resulted from his work on integral equations, while Topology came to the fore as a result of Riemann's study of areas and integration over complex numbers. Topology is not simply a matter of Möbius strips and Königsburg bridges with which to amuse students. It is only when a student gets an insight into the interdependence of the various topics and their place in the whole, that Mathematics can become meaningful to him (38, p. 221). A Mathematics teacher with such an insight into Mathematics will surely not present his lessons as a series of recipes and techniques which have to be applied to specific types of problems. If he can put across to his pupils that Euclidean Geometry is only one of several geometries, for instance, he will have made Euclidean Geometry more meaningful for them and stimulated interest in the various geometries as well. The idea of Mathematics as a logical system which has been developed by man is of the greatest importance, yet it is seldom if ever implemented in the schools.

It must not be thought, however, that a better understanding of the meaning and place of the various mathematical topics is all that is needed to bring about a complete revival of the pupils' interest. Something more than the mere inclusion of new subject matter in the syllabus is needed. A topic such as Sets for instance, was recently introduced into the syllabuses both here and overseas because it was thought that an elementary knowledge of Set Theory and the Set notation would provide an excellent base for all the other topics while emphasizing the structural side of Mathematics. Yet strong misgivings are being voiced today about the value of teaching Elementary Sets because "the problem really is not what kind of mathematics should be taught, but <u>how</u> it is to be taught ... The biggest wrong in the 'traditional' mathematics was and is not the content but the methods; algebra was presented as a bag of tricks, a collection of meaningless manipulations, and geometry as a tiresome suc= cession of theorems and 'riders' " (13, p. 3). The "how it is to be taught" is the crux of the matter. The Mathematics teacher must have a pedagogically and didactically sound training. He must have clearly defined aims when he stands in front of his class. His preparation must be based on didactical considerations so that situations are mathematized and the pupils can approach the subject intuitively instead of being burdened with countless exercises.

In order to find the best way of getting this approach to take root, a thorough investigation of the present position with regard to the training of Mathematics teachers is imperative. This report represents a move in the direction of such an investigation in that it describes the present situation with regard to the training of Mathematics teachers in the Republic of South Africa and then offers a few recommendations.

1.4.2 <u>The shortage of Mathematics teachers</u>

The shortage of Mathematics teachers is another aspect which makes research into the training of teachers for this subject an absolute necessity.

a. The primary school

Because of the fact that subject teaching in the primary schools has only recently been allowed in the Transvaal while some pro= vinces do not officially have it at all (the O.F.S. has subject teaching in the upper standards in most of its primary schools), no figures are available as to the shortage or surplus of Mathematics (Arithmetic) teachers on this school level for the Republic of South Africa. As Mathematics (Arithmetic) is and always has been a compulsory subject in primary school teacher training programmes, a possible shortage of Mathematics (Arith= metic) teachers in South Africa will thus depend on the overall supply of primary school teachers. Judging from the fact that the emergency two-year primary school teacher's diploma in the Transvaal, for instance, was discontinued in 1963, and taking into account the new legislation which has to all intents and purposes increased the duration of primary teachers' training courses from three to four years, it seems that there is no shortage of primary school teachers in the Republic of South Africa at present. There is, however, an ever increasing shortage of male teachers in the primary schools resulting in primary schools often having only one or two men on the staff, generally the headmaster and the vice-principal. This growing shortage of male teachers in the primary schools, although not of importance as far as the teaching of Mathematics is concerned, is a factor which has direct bearing on discipline. Male teachers are just as necessary, if not more so, in the primary school as in the secondary school. No mention of any shortage could further be found in any of the provincial publications as far as primary school teachers are concerned. Any review of the shortage of teachers, however, must also consider the qualifi= cations of the teachers. Not only must there be an adequate supply of teachers, but they must also be adequately qualified, especially in a subject like Mathematics. Two most important questions in this respect are:

(i) What should the minimum qualification in Mathematics be for enrolment as a student teacher for the primary school as regards general training and subject training?

(ii) What should the minimum requirements in mathematical ability be for certification as a primary school teacher?

An adequate supply or a surplus of teachers, however, is something which can only have a beneficial effect on the quality of teaching in all the primary school subjects including Mathema= tics.

b. The secondary school

It is an extremely difficult task to determine the shortage of teachers in any subject in any of the provinces in the RSA. "Officially" there is no shortage because all the classes in every school have teachers standing in front of them. Now one may reason that a good reflection of the shortage of teachers experienced in a specific subject may be gained by looking at the number of posts advertised for that subject in the provin= cial gazettes. This, in fact, was done in a report on the shortage of teachers (39) and it was found that in 1971 the subject in which the greatest shortage of teachers occurred in the Transvaal was Mathematics with 30,1 per cent (39, p. 132). However, this figure was later found not to be very accurate seeing that many schools decided to readvertise their Arithme= tic posts as Mathematics posts. It was then decided to inves= tigate another aspect with regard to the shortage of Mathematics teachers.

Once again,however, any review of the shortage of teachers, especially where it concerns a specific subject such as Mathe= matics as is the case in this study, must also consider the qualifications of the teachers. It is unfortunately true that as soon as a shortage arises in any sphere, standards of selec= tion tend to crop.

The following tables, Tables 1.2 - 1.8, reflect the position with regard to the qualifications of teachers arranged according to the present minimum requirements for secondary school teachers as per Statute No. 39 of the National Education Policy Act of 1967. This Statute specifies that a secondary school teacher must have a minimum of four years of training, either by way of a three-year degree followed by one year of profes= sional training or by way of four years of academic-professional training.

In view of research findings as illustrated in Tables 1.2 - 1.5 and on account of the study of the position in overseas countries it can be stated that the shortage of teachers is a problem that most western countries are concerned with. The greatest shortage overseas and in the Republic of South Africa occurs in the science subjects and Mathematics. The overall shortage of teachers which occurred after World War II was caused by factors such as a high birth rate after the war, the democratic idea that education must be open to all and the weak position of the teaching profession which simply could not compete with the private sector as regards salary and status. Mathematics and

Science teachers especially were enticed away into the private sector where the technological-scientific boom can be seen as a second industrial revolution. In order to obviate the shortage of subject teachers, inadequately qualified teachers were ap= pointed in an ever increasing way both in the Republic of South Africa and overseas. Only during the past four or five years has the shortage been stemmed to a certain extent as the result of increased salaries and better working conditions, both leading to higher status. Very attractive bursaries are also being offered by the education departments, especially to students intending to teach Mathematics, Science or any of the languages. However, these measures only seem to make the teaching profession more attractive to women, as can be seen from the fact that the male-female ratio decreased from 1,24: 1 in 1967 to 1,09: 1 in 1971 (39, p. 146).

As regards the appointment of teachers not properly qualified in order to combat the shortage of teachers in specific subjects the following findings are significant: "Die natuurwetenskap= like vakke, wiskundige vakke en handelsvakke se onderwysers se kwalifikasies is heelwat onder die gemiddelde. Byvoorbeeld: In 1971 het 53,3 persent van al die Wiskundeonderwysers oor twee of meer jare opleiding beskik in 'n wiskundige vak teenoor 90,9 persent in Duits, 66,0 persent in Engels en 80,9 persent

per cent in 1972. Figures for 1973 and later are as yet un= available. If these figures are analysed province by province the following picture emerges as regards the qualifications of Mathematics teachers: In the Transvaal only 41,5 per cent of the Mathematics teachers had at least passed Mathematics II at university while in 1972 this percentage decreased to 40,3. For the Orange Free State the corresponding percentages for 1971 and 1972 are 52,6 and 57,6. In Natal the positions seems to be the most critical with the percentage of teachers with at least Mathematics II to their credit having dropped from 45,2 per cent in 1971 to only 30,1 per cent in 1972. In contrast to Natal the position in the Cape Province in 1971 appears to be relatively healthy with 64,7 per cent of the Mathematics teachers having passed at least Mathematics II at university. This figure then increased to 65,3 in 1972. Invariably Mathematics teachers (together with Physical Science and Biology teachers) occupy the bottom positions as regards qualifications (see Tables 1.2 - 1.8).

Taken together with another finding from the same report namely that of the temporarily appointed teachers, the position with regard to the quality and supply of Mathematics teachers in South Africa must give rise to considerable concern: "In 1971 was daar relatief meer tydelike onderwysers in die Republiek van Suid-Afrika as in 1967 - ten spyte van die feit dat getroude onderwyseresse in Transvaal sedert die begin van 1970 in per= manente poste aangestel kon word. In 1971 was 26,6 persent van al die sekondêre onderwysers tydelik aangestel (26,7 for the academic subjects only) teenoor 21,3 persent in 1967 (20,4 for the academic subjects only). Die persentasie tydelike personeel nie geskik vir permanente benoeming nie, het in dieselfde tydperk vermeerder van 6,1 tot 12,3. Engels (33,8 persent), Rekenkunde (27,9 persent), Afrikaans (27,6 persent), en Wiskunde (25,6 persent) is die akademiese vakke met die grootste persentasie tydelike onderwysers" (39, p. 145). The figure for the Physical Sciences is 22,5 per cent. The latest figures available for these subjects (as regards the teacher position), those for 1972 are: English 35,5 per cent, Afrikaans 29,3 per cent, Mathematics 25,3 per cent and Physical Science 24,5 per cent (see Table 1.1). If it is kept in mind that it is largely the temporarily appointed teachers who are responsible for the turn-over of staff, these figures indicate an increasing degree of instability in the schools which can only have a detrimental effect on the teaching of the subjects concerned. While the figures for 1972 show a deteriorating position for nearly all the subjects, they seem to show an improvement for Mathematics. However, Arithmetic as a school subject was discontinued as from 1972 in Natal with the result that many Arithmetic teachers were appointed in Mathematics posts which could cause the figures for Mathematics to show this favourable trend. See Table 1.1 for further particulars.

When the above figures are combined to gain an overall impression with regards to the qualifications of secondary school teachers in the Republic as a whole, the following dismal picture emerges: 30,6 per cent of all Mathematics teachers in the RSA were not in possession of the present required qualifications in the RSA in 1971. (The National Education Policy Act No. 39 of 1967 stipulates that a secondary school teacher must receive at least four years of training, either by way of a degree followed by one year of professional training or by way of four years of academic-professional training). In 1972 this percen= tage rose to 31,4 (Table 1.6).

Table 1.7 gives an indication of the percentage teachers in the RSA who do satisfy the minimum requirements of training men=

tioned above but who are teaching subjects, apart from their main subjects, in which they are unsatisfactorily qualified. In 1971 therefore, a further 16,7 per cent of the teachers teaching Mathematics were unsatisfactorily qualified in Mathematics. This figure rose to 17,9 per cent in 1972.

If the figures given in Tables 1.6 and 1.7 for Mathematics are taken together to give a single figure representing the un= satisfactorily qualified teachers it transpires that in 1971 47,3 per cent of the teachers teaching Mathematics were not suitably qualified in Mathematics. This percentage increased to 49,3 in 1972 (Table 1.8).

In the light of the above description of the position with regard to Mathematics teachers it becomes clear that a closer look must be taken not only at the training of Mathematics teachers as is done in this particular survey, but at all aspects of the teaching profession.

1.5 INSTITUTIONS IN THE REPUBLIC OF SOUTH AFRICA AT WHICH MATHEMATICS TEACHERS RECEIVE THEIR ACADEMIC AND PRO= FESSIONAL TRAINING

In November 1968 a report on the training of White teachers in South Africa which was prepared by a commission of inquiry under the chairmanship of Dr J.S. Gericke, was laid before the Minister of National Education. One of the most important recommendations of the commission in this report was that the training of all secondary school teachers, except in the case of a few practical subjects, should be done by the universities. The provincial colleges of education should then be responsible for the training of primary school teachers only, but this too should be with the close co-operation of the universities. The recommendations of the Gericke Report were accepted and placed on the Statute Book in 1969 as the National Education Amendment Act, Number 73 by the Parliament of the Republic of South Africa. In order to carry out the provisions of the new Education Act Number 73 of 1969 the Minister of National Education subsequently ordained by way of Notice 1103 in the Government Gazette dated 10 July 1970 that all secondary school teacher training courses, as were then being offered by the provincial colleges of education, should be terminated by the 31 Desember 1975 (3, p. 297).

The universities in South Africa which are affected by this legislation and which are therefore concerned in this study are the following:

a. The University of Cape Town.
b. The University of Natal.
c. The University of the Orange Free State.
d. The University of Port Elizabeth.
e. The Potchefstroom University for Christian Higher Education.
f. The University of Pretoria.
g. The Rand Afrikaans University.
h. Rhodes University.
i. The University of Stellenbosch.
j. The University of South Africa.
k. The University of the Witwatersrand.

In contrast to the provincial colleges of education which fall directly under one of the four provincial departments of edu= cation, the universities are autonomous institutions. This means that each university is free to arrange its teacher training curricula and subject syllabuses as it wishes, subject though to the provisions of the November 1972 revised edition of the Criteria for the Evaluation of South African Qualifica= tions for purposes of employment in Education. Republic of South Africa (37). A study of each of the universities' training courses for Mathematics teachers was therefore required. The position at all the provincial colleges of education in each specific province, on the other hand, did not all need investigation seeing that each province's Department of Edu= cation concerned laid down the curricula and syllabuses for all its colleges. The Cape Province has at present seven teachers' training colleges, one in each of the following centres: Cape Town (English medium), Graaff-Reinet, Oudtshoorn, Paarl, Stellenbosch and Wellington (all Afrikaans medium) and one at Grahamstown (English medium). These teachers' training colleges are on the whole smaller institutions than those in the Transvaal. The Transvaal has at present four teachers' training colleges, two of which are in Johannesburg (one English and one Afrikaans medium), one in Pretoria and one at Potchefstroom (both Afrikaans medium). Natal has three teachers' training colleges, one in Durban (Afrikaans medium), one in Pietermaritzburg and one in Pinetown (both English medium), while the Orange Free State has only one teachers' training college in Bloemfontein (Afrikaans medium).

1.6 THE METHOD OF RESEARCH

Initially a thorough study was made of teacher training in certain Western European countries with special emphasis on the training of Mathematics teachers. The teacher training programmes of the following countries were studied:

The United States of America, England and Wales, Belgium, the Netherlands and West Germany. The embassies of these countries in Pretoria were contacted for the latest information but other= wise this investigation proceeded mainly through a study of the available literature. A research officer of the Human Sciences Research Council, Mr P.G. Human, went overseas in October 1972 to attend the Second International Mathematics Convention which was held in Exeter, England. Visits to the education depart= ments of England, Belgium and West Germany were arranged for him and he brought back much valuable information, also in connection with this project.

However, it soon became evident that teacher training program= mes in the countries studied were developed to overcome problems that were peculiar to each and that their programmes as such could not be implemented here to overcome our problems. Certain aspects of their solutions could well be of great help to South Africa, however, and where necessary recommendations to this effect have been included in the final chapter of this study.

Interviews were furthermore arranged with the Deans of the Faculties of Education or the persons specifically in charge of the training of Mathematics teachers at the following institutions in the Transvaal:

a. The Potchefstroom University for Christian Higher Education.
b. The Pretoria Teachers' Training College.
c. The University of the Witwatersrand.
d. The Rand Afrikaans University.
e. The University of South Africa.

Much valuable information was gained from these interviews but it also became clear that very little store could be put by the calendars of the various universities. As a result of this and because of the fact that visits to the remaining universities would incur unnecessary expense, questionnaires to each of the remaining universities were drawn up. These questionnaires were compiled specifically for each university asking direct information about the accuracy of the regulations in their calendars and requesting an exposition of their teacher training programmes if it differed from the version in their calendar for 1973.*

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* In this respect it must be mentioned that in cases where references are not given, the information used was obtained from questionnaires.

1.7 A PREVIEW OF THE ENSUING REPORT

In Chapter 2 the training of primary school teachers at South African universities is reviewed with special emphasis on the mathematical courses. Not all the universities provide courses for the training of primary school teachers. In Chapter 3 the training of primary school Mathematics teachers at the provin= cial colleges of education is described. In both Chapters 2 and 3 the investigation was undertaken under the following headings:

Compulsory Mathematics courses,

Optional Mathematics courses, and

Methods courses in Mathematics.

In Chapter 4 the training of Mathematics teachers for the secondary schools is reviewed. Under the new legislation this training is only to be found at the universities except for a few training courses which are soon to be terminated. In Chapter 5 a description of the training of Mathematics teachers in selected Western countries is given and in the final chapter, Chapter 6, some conclusions and recommendations are offered.

TABLE 1.1

THE TEMPORARILY APPOINTED STAFF EXPRESSED AS A PERCEN=
TAGE OF THE TOTAL NUMBER OF STAFF TO TEACH A SUBJECT
AS FIRST SUBJECT IN THE RSA AND SWA

Subject	1967	1969	1971	1972*
Geography and related subjects	11,6	19,2	20,7	18,1
Afrikaans	22,5	28,9	27,6	29,3
Biological subjects	18,1	28,0	22,2	21,2
German	17,1	21,4	21,7	26,4
English	28,1	36,5	33,8	35,5
Physical Sciences	17,4	21,2	22,5	24,5
History and related subjects	13,9	17,6	15,2	16,5
Commercial Subjects	15,7	18,9	15,1	17,4
Classical languages	20,6	24,6	23,3	17,8
Arithmetic (to Std. 8)	21,7	33,2	27,9	-
Mathematics	19,9	27,5	25,6	25,3
Other academic subjects	26,2	31,3	30,5	-
Academic subjects taken as a whole	20,4	26,7	24,7	25,4

(39, p. 131)

* The 1972 figures include the teachers in the technical schools while the 1967 and 1969 figures do not.

TABLE 1.2 (39, p. 109)

THE TEACHERS IN THE TRANSVAAL ARRANGED ACCORDING TO THE PRESENT MINIMUM QUALIFICATION REQUIREMENTS FOR SECONDARY SCHOOL TEACHERS

Subjects	4 years or more training												3 years or less training				Total		
	Group 1: 2 U +**				Group 2: 3 C +**				Group 3: 1 U, 2 C										
	N		%		N		%		N		%		N		%		N		%
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971/72
Geography/related subjects	248	262*	69,5	61,5	1	8	0,3	1,9	40	59	11,2	13,8	68	97	19,0	22,8	357	426	100,0
Afrikaans	673	799	64,2	63,4	17	42	1,6	3,3	90	130	8,8	10,3	268	289	25,6	22,9	1048	1260	100,0
Biological subjects	258	264	49,2	49,7	26	39	5,0	7,3	50	60	9,5	11,3	190	168	36,3	31,6	524	531	100,0
German	190	185	89,2	90,3	0	1	0,0	0,5	12	9	5,6	4,3	11	10	5,2	4,9	213	205	100,0
English	547	640	54,2	53,9	19	34	1,9	2,9	133	148	13,2	12,5	311	366	30,8	30,8	1010	1188	100,0
Physical Science	232	263	41,7	39,5	12	37	2,2	5,6	105	132	18,9	19,8	207	233	37,2	35,0	556	665	100,0
History/related subjects	454	506	70,4	67,4	9	7	1,4	0,9	62	84	9,6	11,2	120	154	18,6	20,5	645	751	100,0
Commercial subjects	336	440	46,1	44,4	36	87	4,9	8,8	54	81	7,4	8,2	303	382	41,6	38,6	729	990	100,0
Classical languages	109	107	84,5	84,3	0	0	0,0	0,0	10	9	7,8	7,1	10	11	7,8	8,7	129	127	100,0
Arithemetic	72	60	17,6	15,8	15	18	3,7	4,7	111	117	27,1	31,8	211	185	51,6	48,8	409	380	100,0
Mathematics	339	387	41,5	40,3	18	53	2,2	5,5	141	173	17,3	18,0	318	348	39,0	36,2	815	961	100,0
Other	70	34	72,9	70,8	0	2	0,0	4,2	10	4	10,4	8,3	16	8	16,7	16,7	96	48	100,0
TOTALS ACADEMIC SUBJECTS	3528	3947	54,0	52,4	153	328	2,3	4,4	818	1006	12,5	13,4	2033	2251	31,1	29,9	6532	7532	100,0

* NB The 1972 figures include the teachers in the technical schools while the 1971 figures do not.

** 1 U = 1 year passed at university; 2 C = 2 years passed at college
2 U = 2 years passed at university; 3 C = 3 years passed at college

TABLE 1.3 (39, p. 108)

THE TEACHERS IN THE ORANGE FREE STATE ARRANGED ACCORDING TO THE PRESENT MINIMUM QUALIFICATION REQUIREMENTS FOR SECONDARY SCHOOL TEACHERS

Subjects	4 years or more training												3 years or less training				Total		
	Group 1: 2 U +*** in subject				Group 2: 3 C +**				Group 3: 1 U, 2 C										
	N		%		N		%		N		%		N		%		N		%
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971/72
Geography/related subjects	104	101*	65,8	64,7	0	1	0,0	0,6	28	30	17,7	19,2	26	24	16,5	15,4	158	156	100,0
Afrikaans	206	239	80,2	76,8	0	2	0,0	0,6	9	19	3,5	6,1	42	51	16,3	16,4	257	311	100,0
Biological subjects	36	41	35,3	39,0	7	4	6,9	3,8	23	27	22,5	25,7	36	33	35,3	31,4	102	105	100,0
German	89	85	87,3	85,9	1	0	1,0	0,0	3	4	2,9	4,0	9	10	8,9	10,1	102	99	100,0
English	152	170	66,1	65,9	0	1	0,0	0,4	21	35	9,1	13,6	57	52	24,8	20,2	230	258	100,0
Physical Sciences	105	118	58,3	59,0	3	2	1,7	1,0	33	34	18,3	17,0	39	46	21,7	23,0	180	200	100,0
History related subjects	112	134	83,0	77,0	1	0	0,7	0,0	6	20	4,4	11,5	16	20	11,9	11,5	135	174	100,0
Commercial subjects	152	165	57,8	55,0	2	4	0,8	1,3	44	55	16,7	18,3	65	76	24,7	25,3	263	300	100,0
Classical languages	22	25	73,3	86,2	0	0	0,0	0,0	3	3	10,0	10,3	5	1	16,7	3,4	30	29	100,0
Arithmetic	27	33	18,6	22,1	13	12	9,0	8,1	48	55	33,0	36,9	57	49	39,3	32,9	145	149	100,0
Mathematics	91	125	52,6	57,6	10	9	5,8	4,1	31	36	17,9	16,6	41	47	23,7	21,7	173	217	100,0
Other	5	0	83,3	0,0	0	0	0,0	0,0	1	1	16,7	33,3	0	2	0,0	66,7	6	3	100,0
TOTALS ACADEMIC SUBJECTS	1101	1236	61,8	61,8	37	35	2,1	1,7	250	319	14,0	15,9	393	411	22,1	20,5	1781	2001	100,0

*** See Table 1.2
* See Table 1.2

TABLE 1.4 (39, p. 107)

THE NUMBER OF TEACHERS IN NATAL ARRANGED ACCORDING TO THE PRESENT MINIMUM QUALIFICATION REQUIREMENTS FOR SECONDARY SCHOOL TEACHERS

Subjects	4 years or more training												3 years or less training				Total		
	Group 1: 2 U + ** in subject				Group 2: 3 C + **				Group 3: 1 U, 2 C										
	N		%		N		%		N		%		N		%		N		%
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971/72
Geography/related subjects	148	137*	63,0	61,4	4	1	1,7	0,4	10	17	4,3	7,6	73	68	31,1	30,5	235	223	100,0
Afrikaans	206	189	51,9	47,1	1	3	0,3	0,7	25	39	6,3	9,7	165	170	41,6	42,4	397	401	100,0
Biological subjects	93	106	51,7	52,7	2	3	1,1	1,5	5	13	2,8	6,5	80	79	44,4	39,3	180	201	100,0
German	38	25	73,1	59,5	0	1	0,0	2,4	1	4	1,9	9,5	13	12	25,0	28,6	52	42	100,0
English	324	243	67,9	58,0	2	7	0,4	1,7	18	26	3,8	6,2	133	143	27,9	34,1	477	419	100,0
Physical Sciences	114	122	50,9	42,1	5	19	2,2	6,6	5	37	2,2	12,8	100	112	44,6	38,6	224	290	100,0
History/related subjects	165	207	75,0	65,5	1	3	0,5	0,9	10	27	4,5	8,5	44	79	20,0	25,0	220	316	100,0
Commercial subjects	20	74	15,2	25,0	5	9	3,8	3,0	8	24	6,1	8,1	99	189	75,0	63,9	132	296	100,0
Classical languages	35	28	71,4	75,7	0	0	0,0	0,0	5	2	10,2	7,5	9	7	18,4	18,9	49	37	100,0
Arithmetic	68	–	23,4	–	8	–	2,8	–	25	–	8,6	–	189	–	65,2	–	290	–	100,0
Mathematics	149	165ø	45,2	30,1	8	30	2,4	5,5	17	87	5,2	15,9	156	266	47,3	48,5	330	548	100,0
Other	21	–	55,3	–	2	–	5,3	–	1	–	2,6	–	14	–	36,3	–	38	–	100,0
TOTALS ACADEMIC SUBJECTS	1381	1296	52,6	46,7	38	76	1,4	2,7	130	276	5,0	10,0	1075	1125	41,0	40,6	2624	2773	100,0

** See Table 1.2
* See Table 1.2

ø NB (i) As from 1972 Arithmetic fell away as a separate subject.
The 1972 Mathematics figures include the Arithmetic teachers.

TABLE 1.5 (39, p. 106)

THE NUMBER OF TEACHERS IN THE CAPE ARRANGED ACCORDING TO THE PRESENT MINIMUM QUALIFICATION REQUIREMENTS FOR SECONDARY SCHOOL TEACHERS

Subjects	4 years or more training												3 years or less training				Total		
	Group 1: 2 U +** in subject				Group 2: 3 C +**				Group 3: 1 U, 2 C										
	N		%		N		%		N		%		N		%		N		%
	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971	1972	1971/72
Geography and related subjects	384	366*	71,8	69,6	2	2	0,4	0,4	53	56	9,9	10,6	96	102	17,9	19,4	535	526	100,0
Afrikaans	556	642	64,8	65,1	14	20	1,6	2,0	124	137	14,5	13,9	164	187	19,1	19,0	858	986	100,0
Biological subjects	193	194	58,5	57,2	39	39	11,8	11,5	66	64	20,0	18,9	32	42	9,7	12,4	330	339	100,0
German	133	126	92,4	86,9	0	1	0,0	0,7	5	8	3,5	5,4	6	10	4,2	6,9	144	145	100,0
English	494	585	63,5	64,1	12	11	1,5	1,2	146	170	18,8	18,6	126	147	16,2	16,1	778	913	100,0
Physical Sciences	430	450	60,1	60,2	46	59	6,4	7,9	125	127	17,5	17,0	114	112	15,9	15,0	715	748	100,0
History and related subjects	331	403	86,4	69,8	3	3	0,8	0,5	20	22	5,2	3,8	29	149	7,6	25,8	383	577	100,0
Commercial subjects	209	280	39,4	42,4	35	41	6,6	6,2	144	131	27,2	19,8	142	209	26,8	31,6	530	661	100,0
Classical languages	81	68	77,1	74,7	1	0	1,0	0,0	15	17	14,3	18,7	8	6	7,6	6,6	105	91	100,0
Arithmetic	2	1	40,0	33,3	0	0	0,0	0,0	1	0	20,0	0,0	2	2	40,0	66,7	5	3	100,0
Mathematics	370	425	64,7	65,3	6	5	1,0	0,8	128	130	22,4	20,0	68	91	11,9	14,0	572	651	100,0
Other	18	5	46,2	62,5	1	0	2,6	0,0	6	1	15,4	12,5	14	2	35,9	25,0	39	8	100,0
TOTALS ACADE= MIC SUBJECTS	3201	3545	64,1	62,8	159	181	3,2	3,2	833	863	16,7	15,3	801	1059	16,0	18,8	4994	5648	100,0

** See Table 1.2
* See Table 1.2

TABLE 1.6

THE PERCENTAGE OF SECONDARY TEACHERS WHO ARE NOT IN POSSESSION OF THE PRESENT REQUIRED QUALIFICATIONS IN THE RSA

		3 years or less of training	
		1971	1972
1.	Geography and related subjects	20,3	24,4
2.	Afrikaans	25,0	23,4
3.	Biology	30,1	27,7
4.	German	9,4	9,1
5.	English	25,5	25,9
6.	Physical Sciences	27,4	26,3
7.	History	14,9	22,0
8.	Commercial subjects	37,1	38,2
9.	Classical languages	10,6	9,2
10.	Mathematics	30,6	31,4
	Average	27,1	27,0

TABLE 1.7

THE PERCENTAGE OF SECONDARY TEACHERS IN THE RSA WHO DO SATISFY THE PRESENT QUALIFICATION/REQUIREMENTS, BUT WHO ARE UNSATIS= FACTORILY QUALIFIED IN THE SUBJECT WHICH THEY ARE TEACHING

		1971	1972
1.	Geography and related subjects	10,0	12,1
2.	Afrikaans	9,8	11,0
3.	Biology	12,7	13,9
4.	German	3,9	4,6
5.	English	12,8	13,6
6.	Physical sciences	16,1	17,3
7.	History	7,2	8,4
8.	Commercial subjects	15,1	12,9
9.	Classical languages	10,6	10,6
10.	Mathematics	16,7	17,9
	Average	12,7	13,7

TABLE 1.8

THE PERCENTAGE OF SECONDARY TEACHERS IN THE RSA WHO EITHER DO NOT SATISFY THE PRESENT QUALIFICATION/REQUIREMENTS OR WHO ARE UNSATISFACTORILY QUALIFIED IN THE SUBJECT WHICH THEY ARE TEACHING (TABLE 1.7 + TABLE 1.8)

		1971	1972
1.	Geography and related subjects	30,3	36,5
2.	Afrikaans	34,8	34,4
3.	Biology	42,8	41,6
4.	German	13,3	13,7
5.	English	38,3	39,5
6.	Physical Sciences	43,5	43,6
7.	History	22,1	30,4
8.	Commercial subjects	52,2	51,1
9.	Classical languages	21,2	19,8
10.	Mathematics	47,3	49,3
	Average	39,8	40,7

CHAPTER 2

THE TRAINING OF PRIMARY SCHOOL MATHEMATICS TEACHERS AT UNIVERSI= TIES IN THE REPUBLIC OF SOUTH AFRICA

2.1 INSTITUTIONS AT WHICH PRIMARY SCHOOL TEACHERS ARE TRAINED

One of the main recommendations of the Gericke Commission which was subsequently included in the National Education Policy Amend= ment Act No. 73 of 1969, was that existing teachers' training colleges should retain their identity and provincial control, but that the training of secondary school teachers should be the function of the universities. The provincial teachers' training colleges would therefore be responsible for primary school teacher-training only as from 31 December 1975. However, the Act stipulates that although the training of White persons as teachers for secondary schools is to be the function of the uni= versities only, the training of White persons as teachers for primary and pre-primary schools shall be provided at a provincial college or a university, subject to the condition that the col= lege and the university work in close co-operation with each other.

The state of affairs at the universities will be considered first.

2.2 MATHEMATICS TRAINING COURSES FOR PRIMARY SCHOOL TEACHERS AT THE UNIVERSITIES

2.2.1 Introduction

Although the universities are permitted to train primary school teachers, not all the universities have elected to do so, but have elected rather to concentrate on the training of secondary school teachers. Those universities which do train primary school teachers under the new Act are in fact only carrying on with the primary school teacher training which they had always done. The following table (Table 2.1) shows the position as regards the training of primary school teachers at South African universities in 1969 under the old dispensation, while Table 2.2 shows the position as at present (1974).

TABLE 2.1

THE MAIN PROFESSIONAL TRAINING COURSES FOR PRIMARY SCHOOL TEACHERS PROVIDED BY THE SOUTH AFRICAN UNIVERSITIES FOR WHITE PERSONS 1969

University	Course*	Duration	Minimum Admission Requirements
Cape Town	Higher Primary Teacher's Diploma in general primary education	3 years	Matriculation or Senior Certificate with aggregate of at least 50%
	Higher Primary Teacher's Diploma with special en=dorsement in art, music or speech and drama	4 years	As above
	Post-graduate Primary Teacher's Diploma	1 year	Bachelor's Degree
Natal	-	-	-
Orange Free State	-	-	-
Potchefstroom	University Primary School Education Diploma	3 years	Senior Certificate
Pretoria	Higher Primary Education Diploma	3 years	Senior Certificate
Rhodes	Higher Primary Teacher's Certificate	3 years	Matriculation
	Graduate Primary Teach=er's Diploma	1 year	Bachelor's Degree
	Higher Primary Teacher's Certificate	3 years	Senior Certificate
South Africa	-	-	-
Stellenbosch	Higher Primary Teacher's Diploma	3 years	Senior Certificate
	Post-graduate Higher Primary Teacher's Diploma	1 year	Bachelor of Arts Degree
Port Eliza=beth	-	-	-
Witwatersrand	-	-	-

(3, p. 281)

* Specialised courses in music have been omitted

TABLE 2.2

THE MAIN PROFESSIONAL TRAINING COURSES FOR PRIMARY SCHOOL TEACHERS PROVIDED BY THE SOUTH AFRICAN UNIVERSITIES FOR WHITE PERSONS 1974

Univer=sity	Course*	Duration	Minimum Admission Requirements	Minimum required qualifications in Mathematics	
				Compul=sory course	Optional course
Cape Town	Primary Teacher's Diploma	3 years	Secondary School Leaving Certificate	None	Std 10
	Post Graduate Primary Teacher's Diploma	1 year	Bachelor's Degree	Std 10	Std 10
	Bachelor's Degree in Primary Education	4 years	Matriculation Ex=emption	None	Matric Ex.
Natal	-	-	-	-	-
Orange Free State	-	-	-	-	-
Potchef=stroom	National Primary Teach=er's Diploma	3 years	Secondary School Leaving Certificate	None	Std 10
	Higher National Primary Teacher's Diploma	4 years	Secondary School Leaving Certificate	None	Std 10
	Post Graduate Senior Primary Teaching Diploma	1 year	Bachelor's Degree	None	Std 10 Matric Ex.
	Post Graduate Junior Primary Teaching Diploma	1 year	Bachelor's Degree	None	Std 10 Matric Ex.
Pretoria	National Teacher's Diploma (Junior Primary)	3 years	Secondary School Leaving Certificate	None	Std 10
	National Teacher's Diploma (Senior Primary)	3 years	Secondary School Leaving Certificate	None	Std 10
	Bachelor of Arts (Edu=cation)	4 years	Matriculation Ex=emption	None	Std 10 Matric Ex.
Rhodes	Higher Primary Teacher's Certificate	3 years	Secondary School Leaving Certificate	None	Std 10
	Graduate Primary Teacher's Diploma	1 year	Bachelor's Degree	None	Std 10 Matric Ex.
RAU	-	-	-	-	-
South Africa	-	-	-	-	-
Stellen=bosch	B. Prim. Ed.	4 years	Matriculation Ex=emption	None	Std 10 Matric Ex.
Port Elizabeth	National Teacher's Diplo=ma (Junior Primary)	3 years	Secondary School Leaving Certificate	None	Std 10
	National Teacher's Diplo=ma (Senior Primary)	3 years	Secondary School Leaving Certificate	None	Std 10
Witwaters=rand	-	-	-	-	-

* Specialised courses in music have been omitted

From these two tables it is evident that the new legislation has not resulted in a great upheaval at the universities as far as primary teacher training is concerned. Those univer= sities that did not have any such courses, have not introduced them while the University of Cape Town and Rhodes University did, in fact, reduce their number of primary school training courses, probably to accommodate the larger number of secondary school teachers. In this chapter the content of the Academic Mathematics Course will be discussed, as well as the Methods courses which the universities offer prospective primary school teachers. In order to view the universities' courses in per= spective it will be necessary to take a closer look at the teacher training requirements as laid down by the National Edu= cation Policy Amendment Act (Act No. 73 of 1969).

The November 1972 revised edition of Criteria for the Evaluation of South African Qualifications for Purposes of Employment in Education: Republic of South Africa stipulates that all three-year training courses for the primary school must include Afrikaans, English, History, Mathematics, Natural Science, Geography, Religious Instruction, Health Education and Environ= mental Studies/Social Science. The Criteria further stipulates that in at least four subjects an academic standard comparable with a first-year degree course must be attained (37, pp. 27-29). Two of these subjects are compulsory, namely one of the two official languages and Pedagogics while the other two subjects must be chosen, one from each of the following two groups (37, p. 28):

a. Mathematics, History, Geography, Biblical Studies, Physical Science (Physics and Chemistry), Biology and Natural Science.

b. Physical Education, School Music, Art, Handicraft, Speech and Drama, School Librarianship and Instrumental Music.

As far as the four-year teacher's training courses are con= cerned the above-mentioned Criteria stipulates that second-year university standard must be attained in at least two academic subjects, one of which must be Pedagogics while the other must be chosen from the following list (37, p. 30):

Mathematics, History, Geography Biblical Studies, Afrikaans, English, Physical Science, Biology and Agriculture (German for South West Africa).

It can be seen that Mathematics figures prominently in the list of specialised subjects. Apart from the above, where Mathe= matics is an optional subject, an academically less rigorous

Mathematics course is compulsory for both the three-year and four-year primary teacher's diplomas.

These stipulations apply not only to the universities but also to the provincial teachers' training colleges.

The problem that has arisen at all the teachers' training insti= tutions, however, is how to devise subject syllabuses for the various non-degree diplomas which the universities can recognise for degree purposes and at the same time satisfy the needs of the prospective primary (and secondary) school teachers enrolling for the various teaching diplomas.

The position with regard to the training of primary school Mathematics teachers at the various universities will now be discussed under the following headings:

a. Compulsory Mathematics Courses.

b. Optional Mathematics Courses.

c. Methods Courses in Mathematics.

a. Compulsory Mathematics Courses

The mathematical courses under discussion here are those courses which the Criteria has stipulated as minimum requirement for all training of primary school teachers (37, p. 27). These courses are usually of an introductory nature and more often than not include the method of teaching the subject to primary school children.

b. Optional Mathematics Courses

The mathematical courses under discussion here are those courses which are available to prospective primary school teachers and which are of first year degree standard. Only those pros= pective primary school teachers who wish to specialise in the teaching of Elementary Mathematics elect to follow this course. The obvious Mathematics Course to offer these students, is the first year Mathematics Degree Course which students with Mathe= matics as major subject take in their first year. One difficulty is that students wishing to take this course must have a matricu= lation exemption in Mathematics. This means that many pros= pective primary school teachers are barred from specialising as a Mathematics teacher in the primary school, although they might have the interest and inclination to do so.

c. Method Courses in Mathematics

Under this heading the courses dealing mainly with the methodology and didactics of Mathematics will be discussed. As has already been mentioned, many institutions include this training in their Compulsory Mathematics Course with the result that they do not offer a separate method course. However, although they are in the minority there are some institutions that do not integrate the mathematical content and its didactics and which consequently offer separate courses.

2.2.2 The University of Cape Town

a. Introduction

At present (1974) the University of Cape Town offers prospective primary school teachers the Primary Teacher's Diploma and the Post-Graduate Primary Teacher's Diploma which is a one-year course. The Primary Teacher's Diploma is a three-year non-degree course. No differentiation between students wishing to specialise in junior primary or senior primary teaching is made. The curriculum of the latter course is as follows (45, p. 10):

"First Year

(i) English I
(ii) Afrikaans and Nederlands I or Afrikaans
(iii) One of the following B.A. or B.Sc. courses:

Mathematics I
History I
Geography I
Religious Studies I
Biology I (or Botany I or Zoology I)
Physics I
Chemistry I
German I (SWA students only)

Second Year

1. Methodology of Education
2. Psychology of Education
3. Primary School Subjects: Method and Content English, History, Mathematics, Science.
4. Teaching Auxiliaries (Oral Communication, Blackboard Technique, Audio-Visual Education)
5. Educational Enrichment Units
6. Skills (Two from: Handicraft, Art, Music, Physical Education)

7. Language skills (Practical Afrikaans)
8. Teaching Practice.

Third Year

1. Philosophy of Education
2. History of Education
3. Methodology of Education
4. Psychology of Education
5. Primary School Subjects: Method and Content Afrikaans, Geography and Scripture
6. Teaching Auxiliaries
   Oral Communication (English and Afrikaans), Health Education, School Librarianship, Seminar Groups in Education
7. Educational Enrichment Units
8. Skills (Two from Handicraft, Art, Music and Physical Education)
9. Language Skills (Practical English)
10. Teaching Practice."

The above diploma course, however, is being discontinued in view of the introduction of the four-year Bachelor's Degree Course in Primary Education as from 1975. During the first two years of this Bachelor's Degree Course students are ex= pected to pass four first-year and two second-year degree courses selected according to the requirements laid down in the Criteria (37, p. 27). During the third year the follow= ing courses must be passed (45, p. 27):

"Third Year

(1) Education I, which includes:

(i) Philosophy of Education
(ii) History of Education
(iii) Methodology of Education
(iv) Psychology of Education.

(2) Primary School Subjects: Content and Method

English A, Afrikaans A, Geography A, History A, Mathematics A, Science A, Biblical Studies.

(3) Teaching Auxiliaries.

Oral Communication (English), Oral Communication (Afri= kaans), Black Board Technique, Audio-Visual Education.

(4) Skills.

Two from: Handicraft A (Women), Art A, Music A, Physical Education A (Women), Physical Education A (Men).

(5) Educational Enrichment Units.

Two from: Careers Guidance, Principles and Practice of Play Production, Puppetry, Oral Interpretation and Assessment, Introducing Art, Introducing Music, Educational Welfare Work.

(6) Teaching Practice.

Fourth Year

(1) Education II

(i) Philosophy of Education
(ii) History of Education
(iii) Methodology of Education
(iv) Psychology of Education.

(2) Primary School Subjects: Method and Content

Three from: English B, Afrikaans B, Geography B, History B, Mathematics B, Science B.

(3) Teaching Auxiliaries.

(4) Skills.

(5) Educational Enrichment Units.

(6) Teaching Practice."

In contrast with the Primary Teacher's Diploma, enrolment for the Bachelor's Degree in Primary Education at Cape Town University is subject to the entrance qualification of the matriculation certificate of the Joint Matriculation Board, or a certificate of full exemption issued by the Board, with an aggregate of not less than 50 per cent. This means that only a select few students will enrol for this degree while the bulk of the primary teachers will be trained at the provincial colleges of education.

b. Compulsory Mathematics Courses

Students still enrolled for the Primary Teacher's Diploma are required to pass the General Primary Mathematics Course during their second year of training. This course is an integrated method and content Mathematics course for which one period a week is set aside. The syllabus for the course is as follows:

"GROUP C: PRIMARY SCHOOL SUBJECT METHODS

CP5: Mathematics

The core of the course consists of a survey of the Mathematics Syllabuses for the Primary School as prescribed by the Cape Education Department and other Provincial Education Depart=ments.

Principles and methods of classroom teaching are dealt with in the various prescribed courses in Methodology of Education. In course CP5 the application of some of these general prin=ciples to the primary mathematics syllabus is illustrated and discussed.

Instruction is given in the performance of mathematical opera=tions and the solutions of problems. Methods of presenting the material to primary school pupils are presented and dis=cussed.

Special emphasis is given to the metric system, mensuration, sets, numeration systems and the elementary concepts of geometry.

Instruction is given in the setting and marking of tests."

Textbooks prescribed for the above course:

"1. Province of the Cape of Good Hope:
Primary School Arithmetic
Teaching Guide

2. de Waal, Levinsohn, Dreyer:
My Fifth Mathematics Book
(Juta)"

With regard to the Bachelor's Degree in Primary Education no details of the Compulsory Mathematics Course are as yet avail= able. As has been mentioned the first students taking this course enrolled at the beginning of 1974 and will spend their first two years completing the academic side of their training. The first students will therefore only be ready for the Com= pulsory Mathematics Course in 1976 during their third year of study and at present the syllabus is still under review.

Students at present enrolled for the one-year Post-Graduate Primary Teacher's Diploma also take the above Mathematics Primary School Subject Methods course during their fourth post-graduate year.

c. Optional Mathematics courses

Students who are at present enrolled for the Primary Teacher's Diploma had the option to choose Mathematics I in their first year of study which was a year devoted entirely to purely academic studies. Three first-year university degree courses had to be passed before a student was allowed to proceed to the second year of study in which the professional training of the diploma course commenced. The Mathematics I degree course is of a high standard with the result that very few if any students enrolled for the Primary Teacher's Diploma attempted it. This is the situation at all the universities offering a non-degree primary school teacher's diploma.

The new Bachelor's Degree in Primary Education offers students who wish to specialise in Mathematics the choice of taking Mathematics I and Mathematics II in their first two years of study. During their fourth year of study those students who did successfully complete Mathematics I and II are expected to take Mathematics B: Method and Content over and above Mathematics A: Method and Content which is compulsory for all third-year students. The Mathematics I and Mathematics II syllabuses are as follows:

"MATHEMATICS 1A

Inequalities and absolute values. Co-ordinates in the plane. Graphs. Functions. Straight lines and circles. Radian measure. Circular functions. Limits of sequences and functions. Diffe= rential Calculus. Maxima and minima. Partial differentiation. Integral Calculus. Areas and volumes. Properties of poly= nomials. Binomial theorem. Systems of linear equations. Matrices.

MATHEMATICS IB

Determinants. Vectors and three-dimensional geometry. Complex numbers. Differential equations of first and second order. Sequences and series. Improper integrals and applications of integration. Conic sections.

References

S. Lang: A First Course in Calculus (2nd ed.).
M.R. Spiegel: Mathematical Handbook.
W. Ledermann: Complex Numbers.
J.A. Green: Sequences and Series.

MATHEMATICS IIA

Syllabus

Elements of Analysis:

The axiom of continuity. Heine-Borel. The nested interval property of the reals. Bolzano-Weierstrass. The Cauchy property of the reals. Sequences. Continuity, uniform continuity. Differentiability. Taylor's theorem. l'Hospital's rules. The Riemann integral. Partial differentiation and applications. Vector valued functions. Extreme values. Multiple and line integration. Green's theorem. Stokes' theorem. Improper integrals. Gamma and Beta functions. Infinite series. Fourier series and Fourier integrals. Differential equations.

Geometry and Linear Algebra:

Solid analytic geometry. Quadric surfaces. Linear equations. Matrices. Gauss reduction. Vector spaces and subspaces. Basis and dimension. Determinants. Eigenvalues and eigenvectors. Elementary functions of a complex variable. Conformal maps.

References

M.H. Protter and C.B. Morrey: Modern Mathematical Analysis.
M.R. Spiegel: Advanced Calculus.
S. Lipschutz: Linear Algebra.

Examinations

Two 3-hour papers in October/November" (45, p. 150).

From the above syllabusses it is clear that the courses are not in any way school orientated. No provision for Mathematics courses which can be termed "school orientated" are made for prospective (primary) school teachers and at present no such courses are envisaged for the near future. The successful completion of the above course, Mathematics IIA, however, is recognised for degree purposes.

d. Method courses

The syllabus for the Primary School Mathematics Method course, together with the textbooks prescribed for the course has already been discussed under point b., Compulsory Mathematics courses, above. This course, together with the specialised fourth-year Mathematics B Methods Course is given in the Faculty of Education and the lecturers are members of this Faculty. In Chapter 6, paragraph 6.1.2(b) the advantages of this arrangement, whereby the professional training is under= taken by the Faculty of Education's staff, is elaborated on and recommended.

A feature of the Mathematics Method courses offered at Cape Town University is the emphasis which is placed on the reading of mathematical literature. A substantial list of books recommended for pupils to read, for teachers to read and general books especially recommended for a school library is given to Mathematics Method students. This list is reproduced in full in Chapter 4, paragraph 4.2.1(c).

Teaching practice is considered an important part of the pros= pective teacher's training. Apart from the continuous teaching practice periods, weekly teaching practice lessons are also arranged. The students spend two days a week on teaching practice, one day English medium and one day Afrikaans medium. Each student gives one lesson and is observed by the others. Afterwards a discussion on all the lessons is held. Since 1972 the University of Cape Town has made use of close-circuit television to give their students the opportunity to evaluate their own performances in mini-teaching situations. This form of teaching practice which originated in the USA and which is known as micro-teaching seems to be an excellent way of making teaching practice more meaningful for student teachers. The University of Cape Town seems to be one of the leaders in this field in the RSA at present. The teachers in the schools assist with the evaluation of a student's work during the conti= nuous teaching practice periods, but not with the evaluation of the weekly practice teaching lessons Teaching practice as arranged above takes place during the second and third years of the Primary Teacher's Diploma Course (which is being phased out), during the third and fourth years of the Bachelor's Degree in Primary Education and during the fourth post-graduate year of the one-year Post-Graduate Primary Teacher's Diploma Course. Teaching practice is considered a subject on its own; it does not form a percentage of any other mark. A separate mark is therefore given for the Method of Mathematics Course and for Teaching Ability. (See Form E Appendix). A candidate must pass each and every subject in the curriculum before the diploma is issued. A candidate who fails teaching practice but passes all his other subjects, is given the opportunity to teach as an uncertified teacher and to be evaluated again after six months or a year as determined by the Board of the Faculty of Education.

2.2.3 The Potchefstroom University for Christian Higher Education

a. Compulsory Mathematics Courses

The Potchefstroom University for Christian Higher Education is one of the few institutions which has a Compulsory Mathe= matics Course, which concentrates on mathematical content only, and which is compulsory for all students intending to become primary school teachers. The course is named Introduc= tory Mathematics (Inleidende Wiskunde) and is taken during the first year of study. The syllabus for the Introductory Mathe= matics course is as follows:

Introductory Mathematics

1. Sets. Elementary operations.

2. Inequalities.

3. The set of natural numbers - operation laws etc.

4. Whole numbers, rational numbers; intuitive approach to the development of the real number system.

5. Length, area, volume, mass, time. The S.I. system.

6. Quadrilaterals, triangles, circles and simple three dimensional figures.

7. Area and perimeter of regular closed figures in a plane. The measurement of angles.

Two periods a week are set aside for the Introductory Mathe= matics course. On the successful completion of this course, a student may decide to become a Mathematics specialist and he would go on with Mathematics Primary IA which will be dis= cussed under the next heading. If he does not wish to spe= cialise in Mathematics, the student will not have any lectures in Mathematics again, although he will follow a compulsory Methods course for primary school Mathematics during the third year.

b. Optional Mathematics Courses

The optional Mathematics Course of first-year degree standard for prospective primary school teachers need not necessarily be the existing first-year Mathematics Courses for degree purposes. The Potchefstroom University for Christian Higher Education has taken up this point of view and compiled a Mathematics Course for prospective primary school teachers which is primary school orientated but still on a first-year university level. Although this course is considered to be on a par with first-year university standards, it is not recognised by the university for degree purposes. Because of the fact that the Potchef= stroom University is the only university which has made a positive attempt to provide a school-orientated optional Mathematics course to cater for Mathematics specialists in the primary school, it is of value to give the complete syl= labus for this course, with this final comment that the course is spread over two years and that only after completion of the second year of this course (Mathematics Primary 1B) first-year standard is attained. The syllabus is as follows:

Mathematics Primary 1A

First Year

1. Number systems:

   Natural numbers, counting numbers, whole numbers, rational numbers, irrational numbers and the theorem of Pythagoras, real numbers. Operations and their laws in the diffe= rent systems. The concept of closedness (geslotenheid).

2. Decimal fractions:

The basic role of the decimal system. Operations.

3. Number systems with bases other than 10.

4. Percentages:

The concept of percentage. Converting percentages to decimal and rational fractions and the converse. Applications.

5. Ration and proportion.

6. Finding the volume of simple three dimensional bodies.

Applications.

7. Gathering and tabling statistical information. Graphical representation of statistical information; point and line graphs on one and two axes; histograms, broken line and circle graphs.

8. Methods of presenting different topics. Capita Selecta.

9. Hints and projects for teaching practice.

Mathematics Primary IB

Second Year

1. Current tendencies in primary school arithmetic.

2. The learning process (leerproses) in Arithmetic.

3. Methods of presenting different topics. Capita Selecta.

4. The planning and production of models and other educa= tional aids.

5. Hints and projects for practice teaching.

6. Elementary calculation of interest rates.

7. Statistical averages (Statistiese gemiddeldes).

8. Powers and exponents.

9. Logarithms and the slide rule.

This syllabus is only a draft syllabus. The syllabuses were still in the planning stage when this report was written. Nevertheless the above draft syllabus does give a good idea of the direction in which the planning is taking place.

c. Methods Courses

If a student of the Potchefstroom University for Christian Higher Education is enrolled for the Higher National Education Diploma for the Primary School and he does not wish to specia= lise in the teaching of Mathematics, then he nevertheless takes Introductory Mathematics during his first year of study and Mathematical Method in his third year of study. On the whole, the practice at the University of Potchefstroom is to let Mathematics lecturers present the Methods Course in Mathematics. There is no objection to this practice, provided that the Mathe= matics lecturers have the necessary qualifications in Education over and above their mathematical qualifications. Otherwise the position could easily arise where the lecturers simply use the time to do more Mathematics.

2.2.4 The University of Pretoria

a. Introduction

The University of Pretoria offers one of two endorsements namely Junior Primary and Secondary Primary for students enrolling for their National Education Diploma (N.E.D.). The Diploma is of three years' duration and the first year is the same for both groups. As from the second year of study the course becomes either Junior Primary or Senior Primary orientated. The curri= culum is as follows (49, p. 35);

First Year

1. Pedagogics I.

2. Afrikaans I or Afrikaans IB.

3. Enlgish I (A or B) or any other course from the fol= lowing two groups:

4. A further course from one of the following two groups:

(aa) Geography, Biology, Biblical Studies, German (for SWA only), History and Mathematics or (bb) Biology or Biological Science, Chemistry, Zoology, Physics, Botany and Mathematics.

Second Year

1. Didactic Pedagogics.

2. Fundamental Pedagogics.

3. Historical Pedagogics.

4. Psychopedagogics (including Orthopedagogics).

5. Subject didactics: Afrikaans (Junior or Senior work).

6. Subject didactics: Mathematics (Junior or Senior work).

7. Subject didactics: English (Junior or Senior work).

8. Religious Instruction.

9. Sports coaching.

10. Speech Training: Afrikaans and English.

11. School organization and administration.

12. Blackboard and Writing (semester course).

13. Teaching practice.

Third Year

1. Orthopedagogics, including Orthodidactics.

2. Psychopedagogics.

3. Sociopedagogics.

4. Subject didactics: Afrikaans (including Library integration Junior or Senior work).

5. Subject didactics: Mathematics (Junior or Senior work).

6. Subject didactics: Enlgish (Junior or Senior work).

7. Subject didactics: Hygiene (Junior or Senior work).

8. Subject didactics: Environmental Studies (Junior work).

9. Subject didactics: Arts and Crafts (Junior or Senior work).

10. Teaching Aids (Including integration of the library).

11. Teaching practice.

As from 1974 the University of Pretoria is offering a B.A. (Ed.) degree, Junior Primary or Senior Primary, specially for primary school teachers. A Matriculation Exemption Certificate is the minimum enrolment requirement and the degree course is spread over four years. The first three years of study are devoted entirely to the academic side of the degree. Students wishing to specialise in Mathematics must take the usual degree courses in Mathematics. During their fourth year of study these students will then take the subject Subject Didactics: Elementary Mathe= matics (Senior or Junior work). This Subject Didactics, Elementary Mathematics Course, incidentally, is compulsory for all students enrolled for this particular degree whether they have any degree courses in Mathematics or not. More details as to the content of the Subject Didactics: Elementary Mathe= matics Course is not available as the first group of students will only be in their fourth year to take it in 1978. The various Mathematics courses will now be examined.

b. <u>Compulsory Mathematics courses</u>

From the above curriculum it will be noticed that the Univer= sity of Pretoria does not offer a pure Mathematics course to those students enrolled for its National Education Diploma. The compulsory course is named Subject Didactics and for this reason these courses will be discussed under paragraph 2.2.4 d. Methods Courses, although some mathematical content is also presented. Further enquiry has revealed that the University of Pretoria is very much against the idea of establishing pure Mathematics courses recognised for degree purposes specially orientated for prospective teachers. The main reason put forward is that such a step would result in the lowering of standards.

c. <u>Optional Mathematics courses</u>

The University of Pretoria makes provision for students enrol= led for the N.E.D. who wish to specialise in the teaching of Mathematics in the Primary School, Junior or Senior Primary, to take the degree course in Mathematics during their first year of study. Students are permitted to take Mathematics I even although they do not have a matriculation exemption pass in Mathematics, a 50 per cent pass in the so-called B-stream Mathematics being the minimum qualification. The content or the tempo is in no way eased to help these students along. The failure rate is therefore extremely high and the students simply steer clear of a subject like Mathematics I.

d. <u>Methods course</u>

The University of Pretoria does not offer a compulsory pure Mathematics course for its students taking the Junior Primary or Senior Primary National Teachers Diploma. However, the University does offer compulsory courses in Mathematical Method known as Subject Didactics: Elementary Mathematics (Junior or Senior work). Separate courses are offered for students who specialise in Junior Primary work as opposed to Senior Primary work, and the courses are spread over two years, the second and third years of study. A university spokesman said that it was impossible to offer the Didactics course without giving the students mathematical content as well because of the wide dif= ferences in mathematical background of the students. The syllabus for the course in mathematical subject didactics is as follows:

NATIONAL EDUCATION DIPLOMA

SUBJECT DIDACTICS: ELEMENTARY MATHEMATICS (JUNIOR PRIMARY)

<u>Second Year of Study</u>

1. The Didactic-pedagogic basis of Elementary Mathematics in the grades with special reference to:

1.1 Didactic forms
1.2 Didactic modalities
1.3 Methodological principles
1.4 The structure of the lesson.

2. Arithmetic readiness and preparatory Arithmetic.

3. Subject content and methodology for the grades with respect to:

3.1 Mathematical vocabulary
3.2 The understanding of number and number values

3.3 The retention of length, capacity, weight and number
3.4 The four basic operations
3.5 Fractions
3.6 Money
3.7 Problems.

4. Practica:

4.1 Teaching practice
4.2 The structure of the lesson
4.3 Teaching aids.

<u>Third Year of Study</u>

1. The Didactic-pedagogic basis of Elementary Mathematics in Std 1 with special reference to:

1.1 Didactic forms
1.2 Didactic modalities
1.3 Methodological principles
1.4 The structure of the lesson.

2. Subject content and methodology for Std 1 with respect to:

2.1 Consolidation and extention of the work done in the grades
2.2 Notation and place values
2.3 Multiplication and division tables
2.4 The four basic operations applied to the natural numbers
2.5 Fractions
2.6 Length, capacity, weight and number
2.7 Size and shape
2.8 Sets.

3. Evaluation in Elementary Mathematics.

4. Practica:

4.1 Teaching practice
4.2 The structure of the lesson
4.3 Teaching aids.

Three periods per week are devoted to the above courses.

The prescribed books used are:

(a) BEHR, A.L. Die onderrig van die nuwe Rekenkunde. Nasou, Kaapstad, 1967.

(b) VAN GELDER, L. Grondslagen van de Rekendidaktiek. Wolters-Noordhoff, Groningen, 1969.

NATIONAL EDUCATION DIPLOMA

SUBJECT DIDACTICS: ELEMENTARY MATHEMATICS (SENIOR PRIMARY)

<u>Second Year of Study</u>

1. Some psychological theories. The present approach.

2. The structure of the lesson (its form, didactical moda= lities and the course of the lesson).

3. The syllabus and scheme of work.

4. Sets.

5. Number concept.

6. Number systems.

7. The four main operations (whole numbers).

8. Number sentences and number theory.

<u>Third Year of Study</u>

1. Consolidation of the previous year's work.

2. Fractions.

3. The use of the S.I. (Systeme Internationale).

4. Graphs.

5. Geometry.

6. Subject policy (aims, class-room practice, revision and evaluation).

7. The study of topics. Analysis of mistakes and prepara= tion of the lesson.

8. Books (evaluation and use).

The above courses resort completely under the Faculty of Edu= cation and are therefore presented by lecturers of this faculty completely independent of the Mathematics Department of the University. As far as teaching practice is concerned, lecturers from the Faculty of Education evaluate the students' criticism lessons (see Form H in the Appendix). Micro-teaching is being experimented with on a small scale at present.

2.2.5 Rhodes University

a. Introduction

Rhodes University at present (1974) offers three different teacher's training courses for the primary school namely the Graduate Primary Teacher's Diploma (GPTD), the Higher Primary Teacher's Certificate (HPTC) and the Lower Primary Teacher's Certificate (LPTC). The appellation of these certificates will change in 1975 in accordance with the decisions of the Minis= ter of National Education. The various Mathematics courses will now be examined.

b. Compulsory Mathematics courses

At Rhodes no provision is made for a compulsory (pure) Mathe= matics course for prospective primary school teachers. Pro= vision is made for a primary school method course in the second and third years of study for students taking the Higher and the Lower Primary Teacher's Certificate. This methods course will be discussed under the heading "Methods courses in Elementary Mathematics" (paragraph 2.2.5 d).

c. Optional Mathematics courses

Two different solutions to the problem of providing a Mathe= matics course on first-year university level have been discussed, namely that of allowing the students who wish to specialise in Mathematics to take the first-year Mathematics degree course, and secondly that of providing a primary school orientated Mathematics course spread over one or more years but still on par with first-year university standard.

Rhodes University has opted for the first solution. Students may opt to do Mathematics I of the B.A. or B.Sc. degree as one of the four first-year academic courses they are required to do.

Very few of them do so although they may pass this course at 45 per cent instead of the usual 50 per cent. In fact, Rhodes University indicated that no students enrolled for the primary school certificates were at present taking Mathematics I.

d. Methods course in Elementary Mathematics

During their third year of study for the Higher Primary Teacher's Certificate at Rhodes University candidates must take the fol= lowing courses and pass in at least three (36, p. 308):

1. Language Teaching
2. History and Geography
3. Arithmetic and Elementary Mathematics
4. Nature Study and Elementary Science.

These courses are listed under the heading Primary School Method. The syllabus for Arithmetic and Elementary Mathematics is as follows (36, p. 325):

"2. Arithmetic

1. The main reasons for the inclusion of Arithmetic in schools.
2. The psychology of learning applied to the learning of Arithmetic.
3. Sets
   Teaching set language and its applications to school Arithmetic.
4. The use of structural apparatus, including Cuisenaire rods and multibasic blocks and Dienes Algebraic Expe= rience Material throughout the school.
5. Teaching methods applied to:

   (i) Development of the number line, including all real numbers.
   (ii) Percentages, including profit and loss problems.
   (iii) The proofs of elementary arithmetic rules.
   (iv) Ratio and proportion.
   (v) Mensuration - shape and size.
   (vi) Inequalities and equations.
   (vii) Graphical representation of information.
   (viii) Fractions, including decimal fractions."

Unfortunately no indication is given as to the number of lec= tures set aside for this course per week.

The above course generally concentrates on three aspects:

1. Psychological and motivating factors.

2. Content:

   (a) A revision of the students' own mathematical know= ledge to a level roughly equivalent to Std 7 accor= ding to the Cape Education Department's syllabus.

   (b) Teaching aspects of the "New Mathematics" which the students have not done at school.

3. Content is taught to the students in the way in which it should be taught to children with the emphasis on the "method of teaching" aspect.

No textbooks are prescribed. Examples are cyclostyled as required although the following two books are recommended for additional reading:

BEHR, A.L. Teaching the New Arithmetic. Nasou, 1967.

DOWNES and PALING The Teaching of Arithmetic in Primary Schools. Oxford Univ. Press.

Up to the end of 1973 the Mathematics Method Course did not necessarily have to be passed in order to qualify for a diploma and a university spokesman high-lighted a serious problem when explaining why this was the position at Rhodes University. According to this spokesman the problem is that many students training to be primary school teachers have a very poor mathe= matical background. If a reasonable standard is demanded in the Method courses of Elementary Mathematics, there is a high failure rate although the students may be satisfactory (or even good) with regard to other courses. Rhodes University's solution up to the end of 1973 was to issue a certificate which omitted Elementary Mathematics so that the students were certi= fied to teach primary school subjects with the exception of Elementary Mathematics. If these students wished to do so, they could rewrite the examination in Elementary Mathematics at the end of subsequent years.

2.2.6 The University of Port Elizabeth

a. Compulsory Mathematics courses

The University of Port Elizabeth refers to the compulsory Mathe= matics course which is taken by all students who enrol for their National Teacher's Diploma (Junior or Secondary Primary) as Rekene I. At present (1974) there are 61 students enrolled for Rekene I. This course is taken in the first year of study and is a purely mathematical course without any Didactics or Methodology as part of it. During the second and third years of study the mathematical Methods course is taken. The syllabus for Rekene I is as follows:

"REKENE

Doseertaal: Afrikaans

REKENE I : WOD I

Eerste en Tweede Semesters

(a) 'n Inleiding tot die Versamelingsleer:

(i) Definisies, basiese begrippe, ens.
(ii) Bewerkings met versamelings.
(iii) Ope en geslote versamelings. Die vereniging en snyding van sulke versamelings.

(b) (i) 'n Saaklike oorsig van enkele ou getalle-stelsels.
(ii) 'n Noukeurige studie van:

Die natuurlike getal
Die heelgetal
Die rasionale getal

(c) Die basiese begrippe in Meetkunde

(d) Oppervlaktes, volumes en vierkantswortel

(e) Inleidende bekendstelling tot sekere algebraïse strukture

(f) Permutasies en Kombinasies

Volgende Hoofstuk

(g) Logika

Inleiding tot die elementêre logika

(h) Wiskundige sisteme"

The University of Port Elizabeth is the only university offering prospective primary school teachers a pure mathematical course before commencing with the teaching aspects of the subject. Even students who only have a Std 6 pass in Mathematics to their credit take the Rekene I course. In their second and third years of study all students must take the Methods courses in Rekene. The syllabuses for the Methods courses in Rekene will be discussed under the heading Methods courses in Mathematics.

The practice of ensuring that all the students have a fair background of Mathematics (Arithmetic) before commencing with the methodology of Mathematics is to be highly recommended. Persons interviewed at other universities have mentioned that there is great need of an orientation course in Mathematics for the students. A further advantage is that the students are busy with Mathematics during all three years of their training. Institutions which offer their Methods course in Mathematics during the second and third years, or even the final year only, have the disadvantage of having students who have not done any Mathematics for a year or two and who have consequently often forgotten enough to lose their confidence in the subject.

The above Rekene I course is offered by lecturers of the Mathe= matics Department. Many of the topics have the same content as the Mathematics I degree course and the Rekene I course is considered on a par with first-year university standard. The textbook prescribed for this course is "Elementêre Algebra vir Universiteitstudente" by Schutte and Van Rooy.

b. Optional Mathematics Courses

In the previous section it was stated that all the students enrolled for the primary school training courses must take Rekene I. This is not strictly true for there is one exception to this ruling, namely that a student may take Mathematics I in place of Rekene I during his first year of study. However, a student wishing to take Mathematics I must have a matricula= tion exemption pass in Mathematics. No student is allowed to take Mathematics I unless he has this matriculation exemption pass in Mathematics and this ruling applies to students enrol= ling for the Four-year Higher National Teacher's Diploma for secondary teachers as well.

The first year degree course in Mathematics at the University of Port Elizabeth is as follows (48, p. 213):

First Semester: Elementary set theory, the real number system, inequalities.
Functions. Finite series.
Limits. Elementary differential and inte= gral calculus.
The trigonometric functions and their in= verses, polinomials and rational functions.
Introductory vectors in algebra and geometry.
(6 lectures and 2 tutorials per week).

Second Semester: Elementary differential and integral calculus continued.
The exponential and logarithmetic functions.
Permutations and combinations, the Binomial Theorem.
Theory of equations. Complex numbers.
Analytical geometry of the straight line and circle.
(6 lectures and 2 tutorials per week).

c. Methods courses in Mathematics

During their second and third years of study students enrolled for the National Teacher's Diploma must choose between the Junior Primary and Senior Primary endorsements. The Methods syllabus for Mathematics reflects this position as can be seen below:

"METODIEK VAN REKENE

Junior Primêr

Metodiek van Rekene I : PJR I

Eerste en Tweede Semester

(Toegepas op Junior Primêre werk.) Besonder-didaktiese waarde en beginsels van die vak. Intra- en intervakkorre= lasie. Metodes van onderrig en klaskamertegnieke eie aan die vak: nuwe beginsels behoort gegrond te word op ont= dekking en bespreking en sover moontlik voorafgegaan word deur praktiese werk en demonstrasie met konkrete materiaal; selfwerksaamheid by die opstel van somme, ander benaderings by berekenings, insameling van data by berekenings, ens; formele drilwerk (voorafgegaan deur begrip) moet in nuwe en verskillende situasies toegepas word; akkuraatheid in syferwerk gepaard met vinnige uitvoering van die berekening; leerling moet deur skatting bepaal of antwoorde binne perke van moontlikheid lê en die antwoorde toets, waar moontlik, deur omgekeerde bewerking; algebraïse metodes behoort aangemoedig te word; stelsel= matigheid en netheid; bekwaamheidsgroeperings. Toetsings= metodes, foute-analises en remediërende maatreëls. Die maak, gebruikmaking en versorging van hulpmiddels en aanskouingsmateriaal. Illustrasie van beginsels d.m.v. demonstrasie-lesse en filmvertonings. Lesvoorbereiding en aanbieding.

Werkskemas.

Metodiek van Rekene 2 : PJR 2

Eerste en Tweede Semester

'n Intensiewe studie van die inhoud van die primêre skool-sillabus. 'n Toepassing van die vakmetodiek op hierdie inhoude.

Senior Primêr

Metodiek van Rekene I en 2 : POR 1 en 2

Eerste en Tweede Semester

Soos vir O.D. (Junior Primêr), maar toegepas op senior primêre werk."

Three periods per week are set aside for their Methods courses in Mathematics. The Mathematics Department and the Faculty of Education both provide lecturers for these courses. At present a lecturer of the Faculty of Education present the Method of Mathematics course for the Junior Primary group and a lec= turer of the Mathematics Department for the Senior Primary group. Students on teaching practice are similarly visited by lecturers from both departments (see Form K in Appendix). Micro-teaching is not in evidence yet since the University is still housed in temporary buildings. No specific textbooks are prescribed - class notes and the prescribed school text= books being considered sufficient.

2.2.7 The University of Stellenbosch

a. Introduction

The University of Stellenbosch has at present two teacher's training courses for the primary school. The one is known as the Higher Primary Teaching Diploma (HPTD) but which is to be terminated by the end of 1974 and replaced by a Primary Teachers' Bachelor degree Course. This Bachelor's degree in Primary Education (B. Prim. Ed.) was introduced during 1973 and is recognised as equivalent to any other Bachelors' degree. Since the HPTD course is not to be continued, only the Bachelors' degree in Primary Education will be discussed. According to a University spokesman it must be kept in mind that as regards the position of the B. Prim. Ed. degree only one year of the course has been completed while the preparation for the second year of the course has been finalised. The present information regarding the third and fourth years of the course may therefore still be altered considerably depending on circumstances.

The curriculum for the Bachelor's degree in Primary Education at the University of Stellenbosch is as follows:

FIRST YEAR

Subjects	Lessons per week
Education I	2
Afrikaans I	4
English I	4
Mathematics I	3
Physical Science I	3
History I	3
Geography I	3
School Music I or School Art I or Arts and Crafts I	3
Religious Education I	2
Speech and Recitation I	1
	28

SECOND YEAR

Subjects	Lessons per week
Education II (Didactics: 2 lessons; Educational Psychology: 1 lesson per week)	3
Afrikaans II	4
English II	4
Mathematics II	3
Physical Science II	3
History II	3
Geography II	3
School Music II or School Art II or Arts and Crafts II	2
Religious Education II	1
Speech and Recitation II	1
Practical Teaching Methodology I	3
	30

THIRD YEAR

Education III (Didactics: 2 lessons; Philosophy of Education and General History of Education: 2 lessons; Educational Administration and the History of Education in SA: 2 lessons, and Edu= cational Psychology: 2 lessons)	8
Afrikaans III	4
English III	4
Religious Education III	2
Speech and Recitation III	1
Practical Teaching Methodology II	3
Two from:	
Mathematics III	3
Physical Science III	3
History III	3

THIRD YEAR (CONTD)

Subjects	Lessons per week
Geography III	3
School Art III	3
	28

FOURTH YEAR

Education IV (Didactics: 2 lessons; Philosophy of Education and General History of Education: 2 lessons; Educational Administration and School Organization: 2 lessons; Educational Psychology: 2 lessons)	10
Two of the following:	
Afrikaans IV	6
English IV	6
Mathematics IV	6
Physical Science IV	6
History IV	6
Geography IV	6
School Art IV	6
	22

The indicated number of lessons per week includes practical lessons Students who wish to enrol for this degree course must have a matriculation exemption pass to their credit, and have passed a mathematical subject at least on the Junior Certificate (Std 8) level. In order to continue with Mathematics in the third year of study, a student must have a matriculation pass in Mathematics to his credit. During the first two years of the B.Prim.Ed. course, Mathematics I and Mathematics II are compulsory for all students. At present students may specialise in the following directions only as far as the B.Prim.Ed. degree is concerned: Physical Education, School Art and School Music. Although no distinction is made between Junior Primary and Senior Primary training, it can be accepted that the B.Prim.Ed.

degree concentrates on the Senior Primary level of education.

The various Mathematics courses will now be examined.

b. Compulsory Mathematics

The following is the syllabus for the compulsory Mathematics course at the University of Stellenbosch:

FIRST YEAR

(3 lecture periods per week)

Arithmetic for the primary school with the methodology of Arithmetic teaching included with each unit.

1. Number concepts and number systems as prescribed for the primary school.

2. Sets as used in the primary school.

3. Approximation and the rounding off of numbers: estima= ting answers.

4. Mental exercises with whole numbers.

5. Decimal fractions and ordinary fractions. Mental exer= cises with rational numbers.

6. Percentages.

7. Ratio and proportion.

8. Money and money transactions. Other monetary systems.

9. Time and calculation of time.

10. Arithmetic problem solving: number sentences; specific emphasis on didactics; problem solving.

SECOND YEAR

(3 lecture periods per week)

Continuation of the Arithmetic for the primary school with the methodology of Arithmetic teaching included with each unit.

1. Measurement in the primary school: Measurement through the ages.

2. The Metric System: S.I. Units.

3. The use of powers and roots with insight into the square=root algorithm.

4. Other number bases. Special emphasis on basic mathema=tical laws as applied in primary school Arithmetic.

5. Algebraic methods in the primary school.

6. Geometry in the primary school. Elementary shapes and forms, symmetry.

7. Perimeter, area and volume.

8. Elementary practical geometry.

9. Scale drawing.

10. Graphs.

11. Educational aids and study aids for the teaching of Arithmetic in the primary school with special emphasis on the use of modern technology for teaching Arithmetic: Programmed teaching, television etc.

12. Evaluation: Tests and testing in primary school Arithme=tic.

13. A critical study of Arithmetic syllabuses and textbooks.

With the introduction of the B.Prim.Ed. degree in 1973, 62 students enrolled. Fifty-four of the students at present take Mathematics as it is compulsory except for students specializing in School Music and Physical Education. As has already been mentioned, students must have at least a Junior Certificate

(Std 8) pass in a mathematical subject in order to be admitted to the above two years of Mathematics and to the degree course as a whole.

c. Optional Mathematics courses

Students who have a matriculation exemption pass and who have passed Mathematics II (B.Prim.Ed. course) may carry on with Mathematics III (B.Prim.Ed. course). This third year Mathe= matics (B.Prim.Ed.) course covers a more advanced study of the Methodology of primary school Mathematics. The psycho= logy of child development and theories in connection with the forming of mathematical concepts with children are included. A section on didactical-remedial Mathematics teaching is done by the Department of Educational Psychology. The syllabus for Mathematics III (B.Prim.Ed.) is as follows:

MATHEMATICS: THIRD YEAR

(3 lectures per week)

1. More advanced Arithmetic method. Special emphasis on aspects of the new approach to the teaching of Arith= metic in the primary school.

2. Experimentation in primary school Arithmetic. New Mathe= matics projects: Structural Arithmetic.

3. More advanced work on Sets.

4. More advanced work on number systems: extension of the number systems: from whole numbers to rational numbers.

5. Development of mathematical concepts by pre-school and primary school children: The contributions of Piaget, Fehr and others.

6. Differentiated Arithmetic teaching. Arithmetic enrich= ment.

7. Learning problems in Arithmetic: Didactic-remedial Arithmetic teaching.

MATHEMATICS: FOURTH YEAR

(6 lectures per week)

1. More advanced work on mathematical axioms.
2. The concept of function in terms of sets.
3. Elementary modular Arithmetic.
4. Systems of linear equations.
5. Finite and infinite series and sequences: Sigma no=tation.
6. Probability.
7. Elementary work on statistical methods.
8. Calculation aids: the slide rule, adding machines etc.
9. Elementary introduction to vector spaces.
10. Introduction to analytical geometry.
11. Elementary work on the principles of logic.

During the fourth year more time is set aside for the study of certain aspects of modern Mathematics. At the successful completion of the fourth year of study, these students are considered to be close to second year university Mathematics standard. It must be clearly stated, however, that such a statement could give rise to misconceptions, for instance certain concepts and sections of the ordinary B.Sc. Mathema=tics I and Mathematics II courses such as limits, continuity, differential and integral calculus are not touched upon in the Mathematics III and IV (B.Prim.Ed.) courses. It is therefore not surprising to learn that once again this course is not recognised by the University for degree purposes.

d. <u>Methods courses</u>

As far as the subject didactics is concerned, the work is done by the same lecturer who presents the Mathematics. The didac=tics is not treated as a separate entity but is integrated with each unit of the Mathematics syllabus as far as possible. Especially during the first two years when Mathematics is compulsory, students are specifically prepared to cope with the primary school Mathematics syllabuses. During the third year a more advanced study of the Methodology of primary school Mathematics is undertaken with topics such as developmental psychology and theories on the child's formation of mathematical concepts. As has already been mentioned, a section on didactical remedial Mathematics teaching is also done by the Department of Educational Psychology. Unfortunately no syllabuses were available for the didactical side of the Mathematics (B. Prim. Ed.) courses. During the fourth year there is less emphasis on Method and more on mathematical background.

As far as teaching practice is concerned, criticism lessons are evaluated by the same lecturers that present the Mathe= matics (B. Prim. Ed.) courses with their integrated didactical aspects (see Form M in Appendix). The lecturers are members of the Department of Didactics in the Faculty of Education. This means that the lecturers are qualified in Education and are not purely Mathematics specialists without any feeling for the didactical aspects of the subject.

2.3 CONCLUSION

As far as the actual syllabuses for the various compulsory elementary Mathematics courses are concerned, it can be stated that only the two pure mathematical (or arithmetical) courses offered by the Potchefstroom University for Christian Higher Education and the University of Port Elizabeth have anything in common. The two syllabuses are as follows: (See Table 2.3)

As far as the training of primary school teachers at the uni= versities is concerned the position is that the training courses have little in common as regards Mathematics. The only uni= versity which has succeeded in developing an academic Mathema= tics course for primary school teachers has found that the training course had to be increased from three to four years so as to be able to spread the academic courses (not only Mathematics) over two years. However, the lengthening of the course to four years is specifically catered for in the Criteria (37, p. 29). Potchefstroom University seems therefore to be the only university of those offering primary school teacher training which has specifically catered for a four-year diploma so as to meet the requirements of the Criteria and at the same time offer their students as wide a choice of subjects as possible.

TABLE 2.3

The pure mathematical courses for primary school teachers which are compulsory

PU for CHE	UPE
(a) Sets. Elementary ope=rations.	(a) Introduction to Sets. (i) Definitions, basic pro=perties, etc. (ii) Operations with sets. (iii) Open and closed sets. The union and inter=section of such sets.
(b) Inequalities.	
(c) The set of natural num=bers - operation laws etc.	
(d) Whole numbers, rational numbers, intuitive ap=proach to the develop=ment of the real number system.	(b) (i) A review of some num=ber systems. (ii) A precise study of the Natural numbers, whole numbers, rational num=bers and real numbers.
(e) Length, area, volume, mass, time. The S.I. system.	(c) Decimal fractions, percen=tage fractions, ratio and proportion.
(f) Quadrilaterals, triangles, circles and simple three dimensional figures.	(d) The basic properties in Geometry.
(g) Area and perimeter of regular closed figures in a plane. The measure=ment of angles.	(e) Areas, volumes and square roots.
	(f) Introductory lectures on certain algebraic struc=tures.

It is difficult to draw a line between those courses which are purely mathematical in content and those which include methodo= logy, because time is often set aside in these methods courses for pure Mathematics before the methodology is discussed. "Another reason is that the available syllabuses are remarkably vague as regards the methodology sections. In some cases no mention is made of methodology at all notwithstanding the fact that the syllabuses are for Method of Mathematics courses."

With the exception of the universities of Potchefstroom and Port Elizabeth, the universities read the ruling "that all primary school courses must include Mathematics" as meaning that this Mathematics includes the Methods or Didactics of Mathematics, which is a valid interpretation seen in the light of many overseas countries' approach. From a didactic-pedagogic viewpoint it is also highly desirable that this be so. However, seen in the light of the fact that all primary school teachers will necessarily teach Elementary Mathematics because of the class-teacher organization in the primary school, it seems to be absolutely necessary that all prospective primary school teachers receive further instruction in Mathematics beyond their school Mathematics. Not only have "new" topics been introduced in the Elementary Mathematics syllabuses in the schools, but the traditional approach to the teaching of the subject has changed. It is doubtful whether a methods course in Mathematics alone can give the students an adequate background for the new (and old) topics as well as help them to find interesting methods of putting the content across.

However, before any thought can be given to raising the content standard of the primary school teachers' Mathematics courses, a most serious obstacle will firstly have to receive attention namely, the complete lack of any admission requirement in Mathematics for students enrolling for the primary teacher's diplomas. The unhealthy situation is now experienced at all the teacher training institutions in the RSA that the Compulsory Mathematics Classes contain students who have no more than Std 6 Mathematics to their credit, others who have Std 8 and some who have Std 10. At a recent one-day conference orga= nised by the Natal Mathematics Teachers' Association with the theme "The Training of Mathematics Teachers", [1] the Chairman estimated that 20 per cent of the students enrolling for the primary teacher's diplomas have only passed Mathematics at the

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1) The Training of Mathematics Teachers Conference held at Pietermaritzburg on Saturday, 18th October, 1975 by the Natal Mathematics Teachers' Association.

Std 6 level. About 50 per cent of the students have Std 8 Mathematics to their credit and 30 per cent Std 10 Mathematics.

Lecturers consequently find that they are compelled to do "revision of the students' own mathematical knowledge to a level roughly equivalent to Std 7 ..." and then to teach ".... aspects of the 'New Mathematics' which the students have not done at school" (paragraph 2.2.5 d). This level of teacher training can only result in a standard of teaching in Mathematics that stiffles all interest and talent in the subject. This problem will be raised later in this survey again (see para= graph 3.6).

"The question may further be raised as to whether the wide diversity as regards not only the Method of Mathematics courses but also the optional Mathematics courses, is desirable. The syllabuses vary considerably from university to university pointing to a serious lack of contact between the syllabus com= mittees concerned of the various universities.

Another aspect of the training of primary school Mathematics teachers that gives rise to concern is the uncertainty sur= rounding the status of the optional Mathematics courses offered to the non-degree students. Although these Mathematics courses were divised to satisfy the requirements of the Criteria as regards standards (37, p. 27-29), not one of them is recognised by the universities for degree purposes. This is a problem that will crop up again in this report, especially in Chapter Four."

CHAPTER 3

THE TRAINING COURSES OF PRIMARY SCHOOL MATHEMATICS TEACHERS AT PROVINCIAL COLLEGES OF EDUCATION

3.1 INTRODUCTION

It has already been mentioned that the National Education Policy Amendment Act (Act No. 73 of 1969) stipulates that the training of White persons as teachers for primary schools shall be provided at a university or at a provincial college of education. The training of primary school Mathematics teachers at the universities was discussed in the previous chapter. In this chapter the training of primary school Mathematics specialists at the provincial colleges of education will be examined.

There are fifteen colleges of education in the Republic of South Africa at present. Seven of these colleges are in the Cape Province, one is in the Orange Free State, three are in Natal and four in the Transvaal. There are no universities or colleges of education for White persons in South West Africa which means that, except for immigrant teachers, all teachers in South West Africa receive their training in the Republic of South Africa.

It is not necessary to examine the training courses at each of the fifteen colleges of education because they are not autonomous institutions. The colleges of education are the responsibility of the respective provincial departments of education which formulate a single policy for all the colleges under their control. It is therefore only necessary to discuss the primary teacher training courses of each of the four provincial education departments namely the Transvaal, the Cape Province, Natal and the Orange Free State in order to cover the whole field. South West Africa has no colleges of education.

In the past the provincial teachers' training colleges trained non-graduate teachers for the secondary schools. At present a limited number of these secondary courses are still being offered at the colleges and will be continued till they are completely phased out by the end of 1975. The primary school teacher training courses will therefore not be lacking in any way as regards accommodation and other facilities.

3.2 THE TRAINING OF PRIMARY SCHOOL MATHEMATICS TEACHERS IN THE TRANSVAAL

3.2.1 Introduction

The new curriculum of the Transvaal Education Department for the training of primary school teachers makes provision for a Junior Primary Course and a Senior Primary Course. Both of these courses can be completed either after three years of study or after four years of study. The students must decide whether they wish to qualify for the three-year diploma or the four-year diploma at the end of the second year. The three-year diploma is known as the Transvaal Teacher's Diploma and the four-year course as the Transvaal Teacher's Higher Diploma. A person who is awarded the first-mentioned diploma has, apart from the professional courses, four academic subjects on first-year degree standard to his credit, namely one of the official languages, Pedagogics and two other academic subjects of his choice. On completion of the four-year diploma, a person has in addition to the four academic credits mentioned above, a further four academic credits so that altogether he has four subjects on first-year degree standard and two on second-year degree standard. Although these courses are considered to be on first-year or second-year standard as the case may be, these courses are unfortunately not recognised as such for degree purposes by the universities. The students' choice of subjects is reasonably limited. Paragraph 11.4.5.5 of the Criteria stipulates that in at least one subject from the list below, the standard of the academic content of the course must be comparable with the standard of a first-year degree course: Mathematics, History, Geography, Biblical Studies, Physical Science, Biology and German (for SWA students only). Mathematics does therefore figure prominently. The curriculum and subject-period distribution for the two primary school teacher's diplomas in the Transvaal is as follows (See Table 3.1 overleaf).

TABLE 3.1

KURRIKULUM EN VAK-PERIODE-INDELING VIR DIE TRANSVAALSE ONDERWYSKOLLEGE. (VAN BEGIN 1972 AF.) (VOLGENS 'N LESINGSWEEK VAN 40 PERIODES VAN 35 MINUTE ELK.)

** 1972

VAK	Junior Primêr					Pre-Primêr (1e en 2e jaar soos vir Jun. Pr.)		Senior Primêr				
	T.O.D.			T.H.O.D.		T.H.O.D.		T.O.D.			T.H.O.D.	
Jare	1	2	3	3	4	3	4	1	2	3	3	4
Pedagogiek (op 1e jaar graadpeil na 3 jaar en 2e jaar graadpeil na 4 jaar)	3	3	5	* 3	6	3	7	3	3	5	* 3	6
Opvoedkundige Siel=kunde		2	2	3	2	3	2		2	2	3	2
Kollegeopening	1	1	1	1	1	1	1	1	1	1	1	1
Kleuterdidaktiek (ontwikkelingspele ingesluit)						5	8					
Godsdiensonderwys	4							5				
Eerste Taal (op 1e jaar graadpeil na 2 jaar + metodiek)	5	5	3	* 2	2	2		5	5	3	* 2	2
Tweede Taal (op vlak soos voorgeskrywe + metodiek)	5	4	3	3				5	4	3	3	
Kleuterlektuur						3						
Wetenskap (El. Na=tuurwetenskap)			2	*	2					3	*	3
Gesondheidsopvoeding			2	*	2					2	*	2
Kleutergesondheidsorg (1e jaar graadpeil na 2 jaar)						3	4					
Wiskunde (Rekenkunde)		3	4	* 2	2	2			5	3	* 2	2
Omgewingsleer		3										
Aardrykskunde			3	3						3	3	
Geskiedenis		3							3			
Skrif en Bordwerk	2							1				

TABLE 3.1 (CONTINUED)

VAK	Junior Primêr					Pre-Primêr (1e en 2e jaar soos vir Jun. Pr.)		Senior Primêr				
	T.O.D.			T.H.O.D.		T.H.O.D.		T.O.D.			T.H.O.D.	
Jare	1	2	3	3	4	3	4	1	2	3	3	4
Skoolbiblioteekwese (Inleidend)	1							1				
Een van : Kuns, Skool=musiek, Liggaamlike Opvoeding, Handwerk	3							3				
Spesialisering (Een van : Kuns, Skool=musiek, Liggaamlike Opvoeding, Handwerk, Skoolbiblioteekwese, Spraak en Drama, Instr. Musiek)	3	4	6	6	6			3	4	6	6	6
OF												
Akad. vak op 2e jaar graadpeil na 4 jaar (+ metodiek daarvan)	3	4		5	3			3	4		45	3
Akad. vak op 1e jaar graadpeil na 2 jaar	4	3						4	3			
Akad. vak op 1e of 2e jaar graadpeil na 4 jaar (+ metodiek vir primêre skool) of Remediërende Onderwys				4	5						4	5
Akad. vak op 1e of 2e jaar graadpeil na 4 jaar (+ metodiek)				4	5						4	5
Ortopedagogiek (1e jaar graadpeil na twee jaar)						4	3					
Spesialisering in Kuns/Handwerk/ Kleutermusiek vir studente wat dit nie reeds geneem het nie. 3 jr / 4 jr						6	6					

TABLE 3.1 (CONTINUED)

VAK	Junior Primêr					Pre-Primêr (1e en 2e jaar soos vir Jun. Pr.)			Senior Primêr			
	T.O.D.			T.H.O.D.		T.H.O.D.			T.O.D.		T.H.O.D.	
Jare	1	2	3	3	4	3	4	1	2	3	3	4
Totale getal periodes per week of siklus	40	40	40	40	40	40	40	40	40	40	40	40
Totale getal lesing= periodes per week' of siklus vir studente	31	31	31	32/30	31/30	32	31	31	30	31	32/30	32/31
Getal vakke per jaar	9	9	9	9	9			9	8	9	9	9

* (Dit staan 'n kollege vry om meer periodes per vak (veral vir die vakke wat baie praktiese werk het) toe te ken.)

** AANGEHAAL

3.2.2 Compulsory Mathematics Courses

From the above curriculum it can be seen that Mathematics (Arith= metic) is a compulsory course spread over two years for the Transvaal Teacher's Diploma and over three years for the Trans= vaal Teacher's Higher Diploma. The Mathematics course starts in the second year of training and includes the methodology of Mathematics. The syllabuses for the Junior Primary and Secon= dary Primary divisions are given below:

TRANSVAAL DEPARTMENT OF EDUCATION: TEACHER TRAINING SYLLABUS FOR JUNIOR PRIMARY STUDENTS FOR THE COURSE THE TRANSVAAL TEACHER'S DIPLOMA AND THE TRANSVAAL TEACHER'S HIGHER DIPLOMA

"MATHEMATICS

SECOND AND THIRD YEAR: JUNIOR PRIMARY

1. INTRODUCTORY REMARKS

1.1 The order of the content of the syllabus and of its sub-divisions is not necessarily an indication of the order in which the topics must be treated. Sections should be integrated as much as possible.

1.2 As far as possible the work must match the class-room situation.

1.3 Students must be given the opportunity to do practical assignments in certain sections.

1.4 Apparatus must be an integrating part of the work and must not be seen as an unrelated section. Students must be well trained to construct their own apparatus cheaply and to use arithmetic apparatus successfully.

1.5 Private study should be encouraged and students should read widely and deeply.

1.6 Both the less gifted and the more gifted student should receive consideration.

1.7 Students who have entered the college bearing an active dislike of arithmetic should leave with at least a positive approach to the subject.

1.8 It is desirable that students have some experience of simple computing machines, e.g. simple slide rules, Napier bones, adding machines, etc.

2. CONTENT

The background, subject matter and method in respect of the following topics is based on the primary school syllabus, with particular reference to Grade 1 to Std 2.

2.1 Number

Number concepts; place value, numbers written in different bases.
The basic properties of the natural numbers and zero.
The four main operations.
Number sentences.
Number patterns.
Pictorial and graphical representations of numbers.
Common fractions, decimal fractions.

2.2 Sets

Application of set concepts in the first school years.

2.3 Measurement

Money, time, metric measurements of length, capacity, weight.

2.4 Geometric concepts

Shapes and their properties.
Geometric patterns.
The size of shapes.

2.5 Ratio and proportion

Student background only.

2.6 Averages

Student background only.

3. METHOD

3.1 Arithmetic readiness

Stages of development with special reference to Piaget, Lovell and others.
Vocabulary and language ability.
Readiness tests.

3.2 Methods of approach

Classical teaching.
Discovery and intuition, discussion.
Group work, individual assignments, projects.
From apparatus to abstract.
Structural systems; principles and techniques.
Films and filmstrips.

3.3 Practice and revision

Oral Work.
Number games, number rhymes and counting activities.
Written work; presentation and accuracy.
Solution of problems.
Consolidation and memorisation.

3.4 Teaching Aids

Classroom apparatus and pupil-apparatus.
Writing books, albums, sum-cards, assignment cards, work cards.

3.5 Administration and organisation

Schemes of work: Grade 1 to Std 2.
Preparation books and record books.
Differentiation.
Workshop and group work.

3.6 Evaluation

Tests: oral and written.
Model tests with memoranda.

4. PRACTICAL WORK

4.1 Handling of apparatus.

4.2 Demonstration lessons.

4.3 Visits to schools.

5. ENRICHMENT

5.1 References and library work.

5.2 Practical applications of arithmetic.

5.3 Study of overseas projects.

5.4 Programmed instruction.

5.5 Simple statistical techniques.

5.6 Popular reading in modern topics such as motion geometry, calculating machines, etc."

TRANSVAAL DEPARTMENT OF EDUCATION: TEACHER TRAINING SYLLABUS FOR SENIOR PRIMARY MATHEMATICS FOR STUDENTS IN SECOND AND THIRD YEAR SENIOR PRIMARY WORK FOR THE COURSE THE TRANSVAAL TEACHER'S DIPLOMA AND THE TRANSVAAL TEACHER'S HIGHER DIPLOMA

"MATHEMATICS

SECOND AND THIRD YEAR: SENIOR PRIMARY

1. AIMS

1.1 To broaden the student's background and to deepen his insight, and thereby to break down his fears of and his prejudice against the subject.

1.2 To give students guidance in teaching techniques in Arithmetic for Std 2 - 5.

2. TIME ALLOCATION

Second and third year: a minimum of 4 periods per cycle.
Lecture periods: 3.
Independent work- or study- periods: 1.

3. METHOD OF APPROACH

3.1 Wherever possible content and method should be treated simultaneously.

3.2 Formal lectures should be kept to the absolute minimum; preference being given to question and answer seminars. Students should experience group work, practical work and the discovery approach at first hand so that they can apply these techniques in the classroom. Methods for both the solution of problems and for teaching can be devised by the students themselves. Students should be given freedom to think for themselves and must not be given prescribed recipes or patterns for arithmetic teaching.

3.3 Students should be encouraged to discuss aspects of the work with each other or with the lecturer.
Lecturers or demonstration lessons given by the lecturer should be followed by discussion.

3.4 Assignments should be phrased in such a way that they encourage students to read widely.
Prescribed books should form the basis but not the limit of their reading.

3.5 Gifted students should be encouraged to make full use of the enrichment programme. (See 6)

3.6 Each college should have at least one fully equipped mathematics workshop where students have the opportunity to do practical work.

4. SUBJECT MATTER

The order of the topics and their allocation to second or third year of study is left to the discretion of the individual colleges.
The background, subject-matter and method in respect of the following topics is based on the primary school syllabus, with particular reference to the work of Stds 2, 3, 4 and 5.

4.1 Application of first year work

A short review of concepts formed in the first year of study; for example: the application of set-concepts to the primary school syllabus.

4.2 Number (Natural numbers and zero)

Number concept; place values, number written in various bases.
The basic properties of the natural numbers and zero.
The four main operations.
Number sentences.
Number patterns.

4.3 Diagrammatic representation

Pictorial and graphical representations of number or of information.

4.4 Number (fractional forms)

4.4.1 Common fractions.

4.4.2 Decimal fractions.

4.4.3 Percentages.

4.5 Measurement

Money.
Time.
Metric measures of length, area, weight and volume.

4.6 Geometric concepts

Basic concepts.
Shapes and their properties.
Geometric patterns.
Sizes of shapes: perimeters, areas and volume.

4.7 Ratio and proportion

(a) Geometrically e.g. variations of length, area, volume etc. in similar shapes.

(b) Arithmetically.

4.8 Averages.

5. METHOD

5.1 Methods of approach

Classical teaching; group work; individual assignments; projects; the use of apparatus.

5.2 Methods of organisation

5.2.1 Schemes of work; preparation book and/or record books.

5.2.2 Oral, written and practical work.

5.2.3 Homework and corrections; neatness and accuracy.

5.3 Methods of revision and evaluation

5.3.1 Consolidation of content.

5.3.2 Structure of tests: evaluation and diagnostic.

5.3.3 Diagnosis and remedial work.

6. ENRICHMENT PROGRAMME

Enrichment of the subject through study and/or discussion.

6.1 Articles in periodicals.

6.2 Programmed instruction.

6.3 Structural apparatus.

6.4 History of mathematics.

6.5 Old methods of computation.

6.6 Number puzzles.

6.7 Films and filmstrips.

6.8 Differentiation within the subject.

6.9 Subject teaching in the primary school.

6.10 Planning a mathematics workshop.

6.11 Statistics: including means, medians and modes.

6.12 Any topic of particular interest to a student e.g. topology, probability ...

6.13 Simple computing machines, e.g. the slide rule, Napier bones, adding machines, etc."

3.2.3 Optional Mathematics Courses

Several years before the passing of the National Education Policy Amendment Act (Act No. 73 of 1969), the Transvaal Educa= tion Department had been granted permission to organise and offer further training for teachers in service in those subjects experiencing a shortage of academically trained teachers. This permission was subject to the condition that the curricula were approved by the universities, seeing that the Transvaal Educa= tion Department aimed at providing these courses up to a level comparable to second-year degree standard. Mathematics was one of these subjects and a Mathematics course was compiled which catered specifically for the needs of the Mathematics teacher in the secondary school. The result was that when the National Education Policy Amendment Act of 1969 was passed, the Transvaal Education Department had a school-orientated Mathe= matics course of second-year degree standard to offer its prospective primary school Mathematics specialists. This syllabus, however, was meant for secondary school teachers and has therefore had to be amended both as regards method and content. The syllabus as it was originally drawn up has not been withdrawn, however. Since in-service and further teacher training is still the domain of the provincial education depart= ments, the syllabus is in use at the new College of Education for Further Training in Pretoria. More will be said about this College later (see par. 4.2.12).

The syllabus for the optional Mathematics course for the primary school teaching students who wish to specialise in Mathematics is as follows:

"TRANSVAAL EDUCATION DEPARTMENT SYLLABUS FOR INTEGRATED MATHEMATICS

1. Introductory remarks

A two year academic ancillary course in Integrated Mathe= matics is offered to students following academic and professional diploma courses for secondary and primary schools.

This ancillary academic subject is however, compulsory for all students following Mathematics as a major subject, in that the subject matter of the ancillary is integrated with the subject matter of the major subject, and the periods of the ancillary are transferred to the major subject.

It is advisable that students who wish to follow the course in Integrated Mathematics, should already have completed a Std-10 course in Mathematics.

2. Aims of the Course

To give the student an academic training as an Arithmetic/ Mathematics teacher, Grade 1 to Standard 8.

To help the student develop a more positive approach in respect of Mathematics.

3. Allocation of periods

Where the subject is taken during the course of the first two years:

First year: a minimum of 4 periods per cycle.
Second year: a minimum of 4 periods per cycle.

Where the subject is taken during the course of the last two years:

Third year: a minimum of 4 periods per cycle.
Fourth year: a minimum of 4 periods per cycle.

4. Method of approach

The subject matter will be dealt with by means of dis= cussions and written explanations.

The activity of the student will consist of practice in and application of the principles discussed.

Extensive reading by the student will be essential for assignments.

INTEGRATED MATHEMATICS FIRST YEAR

1. Sets

Concepts, terminology and notation.

Relation between (a) elements and sets;

(b) sets.

Operations on sets.

Sets of ordered pairs. Cartesian product.

2. The structure of the real number system and complex numbers

2.1 The Number Concept

The number concept; ordinal and cardinal numbers; number and numeral.
Earlier numeration systems.
Place value and the denary system.
Multibase arithmetic.

2.2 The Natural Numbers and the Whole Numbers (Cardinal Numbers)

Order. Graphical representation.
Basic properties.
The four fundamental operations.
Some important subsets: Prime numbers; multiples of numbers; even numbers, squares; etc.

2.3 The Integers

Definition. Notation. Order. Graphical representation.
Basic properties.
The four fundamental operations.
Some important subsets: Positive integers; non-negative integers; negative integers; even integers; etc.

2.4 The Rational Numbers

Definition.
Notation: numerator-denominator; ordered pairs; decimal point; percentage.
Order. Density. Graphical representation on number line and on plane.
Basic properties.
The four fundamental operations.

2.5 The Real Numbers

The irrational numbers: definition.
Pythagoras and irrational numbers.
The set of real numbers as the union of the sets of rational and irrational numbers.
The field of real numbers.

2.6 The Complex Numbers

Concept. Definition. Notation. Graphical representation.
Fundamental operations.
Application to simple factorisation and solution of equations.

3. Number Sentences

4. Relation, Ratio, Rate, Proportion

4.1 Relation

Concept. Equivalence relation.
Representation in practical situations by means of tables, formulas, graphs and mappings.

4.2 Ratio

Concept. Notation. Distinction between ratios and rational numbers.

4.3 Rate

Concept. Practical applications. Distinction between ratio and rate.

4.4 Proportion

Direct and inverse proportion and their graphical repre= sentation. Practical application.
Laws of proportion.

5. Commercial Arithmetic

Commission.
Profit, loss, discount.
Revenue (Government, provincial, municipal).

6. Introduction to Algebra

6.1 Polynomials

Fundamental operations.
Factorisation.

6.2 Algebraic Fractions

Simplification.
Fundamental operations.

6.3 Exponents and Radicals

Positive integral exponents.
Rational exponents.
Simplification of radicals.
Absolute value.

7. Relations and functions

Cartesian product.
Definition and notation of function and relation.
Mappings.
Graphical representations of simple relations and functions.
Domain. Range.
Inverse functions.

8. Equations and Inequalities in one or two variables

8.1 Solution and graphical representation of:
Linear equations and inequalities.
Simultaneous equations and inequalities.
Linear programming.

8.2 Quadratic equations and inequalities.

8.3 Roots of polynomial equations (simple cases only).
The Remainder Theorem.

9. Exponential and Logarithmic Functions

Exponential function.
The number e.
Logarithmic function.
Natural logarithms.
Logarithms with base 10.
Computation with logarithms.
Exponential equations.

10. The Slide Rule

Theory of construction.
Multiplication; division; powers; roots; reciprocals.
Trigonometric scales.

SECOND YEAR

11. Sequences and Series

Simple number patterns. Pascal's triangle; Fibonacci numbers; etc.
Finite and infinite Arithmetic and Geometric Sequences and Series.
Summation of finite series.
Limit of a sequence.
Elementary concept of "convergence and divergence".
The Binomial Theorem.

12. Commercial Arithmetic

12.1 Interest: Simple interest; banker's discount; compound interest; savings accounts; hire purchase; depreciation.

12.2 Insurance.

12.3 Pensions.

12.4 Bankruptcy.

12.5 Partnerships.

12.6 Rates of Exchange.

13. Measurement

Concept. Quantitative measurement. Standard units.
The reliability of measurement.
Precision and accuracy.
Scientific notation.
Significant figures.
Computing with measurements.

14. Shape and size

14.1 One, two and three dimensional shapes (regular and irregular); names and characteristics.

14.2 Two dimensional shapes: Geometric properties as regards angles, sides, symmetry, congruency, similarity, etc.
Size: perimeter and area.

14.3 Three dimensional shapes: Geometric properties.
Size: surface area and volume.

14.4 Deductions and graphical representation of relationships that arise in practical situations.

14.5 Elementary Transformations: Topology. Reflection, rotation and translation.
Shearing.

15. Permutations and Combinations

15.1 Permutations

Definition. The symbol ${}^nP_r$.

Calculation of the value of ${}^nP_r$.

The notation $n!$
Practical applications.

15.2 Combinations

Definition.

Calculation of the value of ${}^nC_r$.

Proposition: ${}^nC_r = {}^nC_{n-r}$.
Applications.

16. <u>Probability</u>

Random experiment and probability.
Sample spaces and events.
Addition of probability.
Pascal's triangle.

17. <u>Statistics</u>

17.1 Fundamental ideas and terms.

17.2 Collection of data, sorting and classification.

17.3 Graphical representation of statistical information.

17.4 Frequency distribution, class intervals, class boundary. histogram, frequency polygon, cumulative frequency dis=tribution, ogive, smoothing.

17.5 Measures of central tendency: Arithmetic mean. Median. Mode.

17.6 Concept of: Range, mean deviation, standard deviation. Skewness.

18. <u>Matrices and Determinants</u>

18.1 <u>Matrices</u>

Definition. Equality. Sum. Zero matrix.
Scalar multiplication.
Product of two matrices. Properties.
Identity matrix for multiplication.
Inverse of a square matrix.
Application to solution of linear equations.

18.2 <u>Determinants</u>

Determinants of order two and three. Properties.
Expansion of determinants by minors.
Cramer's Rule for solution of a system of linear equations.

19. Analytical Geometry and Trigonometry

19.1 Analytical Geometry

Rectangular coordinates: Ordered pairs.
Concept of polar coordinates.
Distance between two points.
Division of a line in a given ratio.
Area of a triangle.
The straight line: Slope, gradient, parallel lines, perpendicular lines.
The circle: centre, the origin.

19.2 Trigonometry

Definition of trigonometric ratios.
Solution of rightangled triangles.
Radian measure.
Graphical representation of trigonometric functions."

3.2.4 Method Courses for Mathematics

The compulsory Mathematics courses discussed earlier under paragraph 3.2.2 are integrated content and method courses as could be seen from the syllabuses given. The following is the Method syllabus for the new Junior Primary syllabus:

"Method:

3.1 Arithmetic readiness

Stages of development with special reference to Piaget, Lovell and others.
Vocabulary and language ability.
Readiness tests.

3.2 Methods of approach

Classical teaching.
Discovery and intuition, discussion.
Group work, individual assignments, projects.
From apparatus to abstract.
Structural systems; principles and techniques.
Films and filmstrips.

3.3 Practice and revision

Oral work.
Number games, number rhymes and counting activities.
Written work; presentation and accuracy.
Solution of problems.
Consolidation and memorisation.

3.4 Teaching Aids

Classroom apparatus and pupil-apparatus.
Writing books, albums, sum-cards, assignment and work cards.

3.5 Administration and organisation

Schemes of work: Grade 1 to Std 2.
Preparation books and record books.
Differentiation.
Workshop and group work.

3.6 Evaluation

Tests: oral and written.
Model tests with memoranda."

The Senior Primary syllabus has a similarly thorough Method syllabus. Particularly impressive is the Enrichment Programme given on page 3 of the Senior Primary syllabus (See paragraph 3.2.2):

"6. Enrichment Programme.

Enrichment of the subject through study and/or discus= sion.

6.1 Articles in periodicals.
6.2 Programmed instruction.
6.3 Structural apparatus.
6.4 History of mathematics.
6.5 Old methods of computation.
6.6 Number puzzles.
6.7 Films and filmstrips.
6.8 Differentiation within the subject.
6.9 Subject teaching in the primary school.

6.10 Planning a mathematics workshop.
6.11 Statistics: including means, medians and modes.
6.12 Any topic of particular interest to a student e.g. topo= logy, probability ....
6.13 Simple computing machines e.g. the slide rule, Napier bones, adding machines, etc."

3.3 THE TRAINING OF MATHEMATICS TEACHERS FOR THE PRIMARY SCHOOL IN THE CAPE

3.3.1 Introduction

In the Cape Province the provincial teachers' training colleges offer aspirant primary school teachers the Primary Teachers' Diploma. This diploma course requires three years of study during which four academic subjects from the following list of subjects must be passed on first-year standard: English or Afrikaans, Pedagogics, Mathematics, History, Geography, Biblical Studies, Physical Science, Biology and German (for SWA students only). One official language and Pedagogics are compulsory, however.

Students have the option of specialising in Junior Primary or Senior Primary work as from their second year of study. It is also possible for students to prolong their term of study from three years to four in order to specialise in teaching subjects of their choice. On completion of the four-year course, a student has four subjects to his credit on first-year university level and two on second-year level.

3.3.2 Compulsory Mathematics Courses

At present the compulsory Mathematics course taken by students enrolled for the Primary Teachers' Diploma is taken during each of the three years duration of the Diploma. During the first and second years three hours per week or five lectures of 35 minutes each are set aside for Mathematics and during the third year seven lectures of 35 minutes each. During the first year all the students do the same work in Mathematics which is purely mathematical. As from the second year, students choose either the Junior Primary or Senior Primary courses and then content and method is integrated throughout the syllabuses. The syllabuses for the Junior Primary and Senior Primary courses are as follows:

a. Primary Teacher's Diploma Course: Mathematics syllabus for the junior standards as for the second and third years

"AIMS

See syllabus for Mathematics for the Senior Standards.

REMARKS

1. It is left to the discretion of the individual Colleges to plan and distribute the work in the second and third years according to their needs.

2. In this syllabus, only the minimum, basic requirements are detailed.

3. At each stage, there should be close integration between content and method.

4. Students' individual work, for which part of the annual mark may be awarded, may be selected from B and/or C of the second year syllabus, and A and/or C of the third year syllabus.

THE SYLLABUS

When planning the programme of work due consideration should be given to the time allocated to the subject and the students' needs. The following division is suggested:

SECOND YEAR

A. Method and Content (± 100 marks)

1. The Theory of Sets

Consolidation and enrichment of the work done in the first year. The concepts formed and the knowledge gained should be applied in practice.

Venn Diagrams, Universal Set, Subset, Union, Intersec= tion, Complement.

The symbols used in Set notation. Simple examples of Set-builder notation.

2. Arithmetic

The four operations in the denary system. Special atten= tion to place value.

Grouping and change of base. (The main aim is to clarify the students' understanding of place value.) Addition, subtraction and counting in base 5, and thereafter in base 2 (counting limited to a number of three digits).

Operations involving 0.

The identify element for the four operations; binary operations.

A knowledge of the units of the metric system.

Operations involving:

(i) Length: cm, m, km.

(ii) Content: ml, l, kl.

(iii) Weight: g, kg.

Calculating the perimeter of a triangle, quadrilateral and circle from given measurements.

Establishing the value of π through measurement and calculation.

Discovering formulae for calculating the area of a square, rectangle, triangle, parallelogram, trapezium and circle.

Finding Square Root (factor method only). Calculating the length of the side of a square and the radius of a circle, where this can be done by finding the square root.

The area and volume of a prism with rectangle, triangle or circle as base.

Ratio and proportion and its application in calculating percentage, discount, commission, profit and loss.

The set of irrational numbers.

3. Graphs

Drawing and interpretating simple pictographs and column graphs.

Graphs to illustrate the multiplication and division tables, relationships and sets of ordered pairs.

Pie Charts to illustrate simple fractions.

An understanding of the terms: axes, origin, co-ordinates, scale.

4. Algebra

Calculating numerical values by substituting in simple formulae; the use of brackets; simple equations with one unknown (first power only).

5. Geometrical Form

An understanding of the following: point, line, line segment, ray, angle, right angle, perpendicular, paral=lel lines, circle, radius, diameter, triangle, quadrila=teral, square, diagonal, rhombus, rectangle, parallelo=gram, trapezium. (No definitions.)

The more important properties of a square, triangle, rectangle and circle (through experiment and discovery).

6. Acquaintance with the requirements of the Arithmetic Syllabus from Sub-standard A to Standard II. (Not examinable in the second year.)

B. Background Study (± 90 marks)

1. The psychological aspect of the study of number.

2. Correlating the child's pre-school mathematical expe=rience with a more systematic study of mathematics.

3. The correlation between the handling of suitable appa=ratus and the motor-sensory learning process.

A further choice may be made from, amongst others, the following:

1. The history of the teaching of Arithmetic.

2. The purpose and value of teaching Mathematics.

3. The new approach to the teaching of Arithmetic.

4. The history of measurement.

C. Teaching Apparatus (± 30 marks)

Apparatus: its value and use as a teaching aid.
The making of examples of suitable apparatus and teaching aids. (This must be kept within reasonable limits.)

THIRD YEAR (± 125 marks)

A. Background Study (± 45 marks)

1. The aims and organisation of Mathematics teaching from Sub-standard A to Standard 1.

The following should receive special attention: group teaching; furniture and equipment; the use of display, apparatus and floor space in teaching; chalk boards; apparatus; discipline; etc.

2. A study of different methods that can be applied to teach the structural form of our arithmetical system. The underlying principles as well as the practical application thereof.

The advantages and disadvantages of each system studied.

B. Content and Method (± 60 marks)

A knowledge of the syllabus from Sub-standard A to Standard II.

A thorough study of the Teaching Guide, Part I (Sub-standard A to Standard I).

The working out of model lessons to cover the whole of the syllabus from Sub-standard A to Standard I.

C. <u>Apparatus</u> ($\pm$ 20 marks)

Apparatus: Its value and use. The making of suitable examples (within limits)."

b. <u>Primary Teachers' Diploma: Mathematics syllabus</u>

<u>"AIMS:</u>

1. To give students a thorough knowledge of and an insight into basic mathematical principles and skills.

2. To make students conversant with the general as well as the particular methods of teaching Mathematics in the Primary School, and to train them in the application of these methods in the preparation and presentation of lessons.

3. To stimulate students' interest in the study of appro= priate background subjects, so that they may instruct more effectively and with deeper insight and greater discernment.

<u>REMARKS:</u>

1. In the light of these aims, the syllabus has been divided into three sections, where this can appropriately be done:

(a) Content

(b) Method

(c) Background study.

2. The minimum basic requirements are set out in this sylla= bus.

3. The order in which the work of each year is to be dealt with, and the time given to each sub-division, are left to the judgement of the lecturers concerned.

4. In the first year, all students follow a general course. From the beginning of the second year, the work of the junior and senior courses is differentiated.

5. The allocation of time is as follows:

First year : 3 hours per week.

Second year : Junior Course – $1^3/4$ hours per week.
Senior Course – $2^1/4$ hours per week.

Third year : $3^1/2$ hours per week.

6. Content and method should be integrated throughout.

First Year

CONTENT:

The syllabus in Arithmetic for the Primary School with special attention to the understanding of, insight into and skill in performing arithmetical operations. The syllabus should be enriched by the understanding of various methods which may be applied to the operations, with special reference to:

1. The theory of sets. Concepts: a set, elements of a set, finite and infinite sets, matching, one-to-one correspon= dence, equal and equivalent sets, cardinal number, the empty set, the universal set, subset, intersection and union, disjoint sets, partition and complement. The diagram= matic representation of these concepts. Symbols and notation.

2. The extension of the number system to include rational numbers:

   (a) The set of natural numbers:

      (i) Closure with respect to addition and multipli= cation.

      (ii) The commutative, associative and distributive properties of the main operations.

      (iii) Inverse operations.

      (iv) Representation of natural numbers on the number line.

   (b) The set of whole numbers (including negative whole numbers):

      (i) Closure with respect to addition, subtraction and multiplication.

(ii) The commutative, associative and distributive properties of the main operations.

(iii) Inverse operations.

(iv) Representation of whole numbers on the number line.

(c) The set of rational numbers (including negative rational numbers):

(i) Closure with respect to addition, subtraction, multiplication and division.

(ii) The commutative, associative and distributive properties of the main operations.

(iii) Inverse operations.

(iv) Representation of the density of rational num= bers on the number line.

3. The use of the number line to illustrate the four main operations (the negative whole numbers excluded).

4. Number sentences:

(a) Open and closed number sentences.

(b) The meaning of the unknown.

(c) Determining the solution set of number sentences with one or two unknowns.

(d) Graphical representation of the solution set on the number line.

<u>BACKGROUND STUDY:</u>

1. A <u>short</u> historical survey of different numeration systems: Chinese, Babylonian, Egyptian, Greek, Hebrew, Roman and Hindu-Arabic.

2. (a) Number systems in different bases, in accordance with the Syllabus for Arithmetic in the Primary School.

(i) Base ten.
(ii) Base five.
(iii) The binary system.
(iv) Base eight.

(b) A discussion of a number system based on twelve.

<u>Second Year</u>

<u>SENIOR COURSE</u>

<u>CONTENT: ARITHMETIC.</u>

1. Consolidation and extension of the work done during the first year.

2. The theory of Sets. Venn diagrams.

   Symbols and notation, including set-builder notation. (Restricted to simple examples only).

3. Further properties of the four main operations on the set of rational numbers:

   (a) Operations with 0.

   (b) The identity element for the four main operations.

4. The four main operations in base 5, base 2 and base 8. (In multiplication and division, the multiplier and the devisor should be limited to a number of one figure.)

5. Graphs.

   (a) Interpretation of simple given column and line graphs. Pie-charts to illustrate fractions, etc.

   (b) The concepts: axes, origin, scale.

   (c) The drawing of simple graphs from data supplied in tabulated form where the scale is given. Simple deductions.

6. The metric system.

   (a) Knowledge of all the units of measurement and weight.

(b) Calculations with:

(i) Length: cm, m, km.

(ii) Area: cm^2, m^2, are, hectare.

(iii) Volume: cm^3.

(iv) Capacity: ml, l, hl.

(v) Weight: g, kg.

ALGEBRA

1. Introduction to the symbolic language of Algebra.

2. The meaning of: factor, coefficient, power, exponent, base, term, expression, degree of an expression, ascen= ding and descending powers, like and unlike terms.

3. The four basic operations. Addition and subtraction of algebraic expressions of the first and second degree, with a maximum of three terms in an expression and with not more than three expressions in an example. In multiplication and division, the multiplier and divisor are limited to monomials.

4. Evaluation of numerical values by substitution in simple formulae.

5. The use of brackets in simple examples.

6. Simple equations with one unknown.

METHOD

1. The aim and value of mathematics.

2. The contemporary approach to the teaching of mathema= tics.

3. General principles of instruction in mathematics.

4. Teaching aids: the nature and use of aids which will illuminate the subject matter; acquaintance with the construction of suitable apparatus (a limited number of

these teaching aids may be made by the students themselves).

5. The methods of teaching the different sections of the syllabus for Std II to Std V.

6. Testing and evaluation of progress.

7. Diagnostic tests and remedial work.

BACKGROUND STUDY

The development of weights and measures, with special reference to the metric system.

Third Year

CONTENT: ARITHMETIC

1. The perimeter of a triangle and a quadrilateral; the circumference of a circle.

2. (a) Area of triangle, parallelogram, trapezium and circle.

   (b) Calculation of the square root by means of factors and application to the calculation of the side of a square and the radius of a circle. The concept: irrational numbers.

3. Area and volume of:

   (a) right prisms on the following bases: rectangle, triangle, circle;

   (b) the sphere.

4. Ratio and its application to percentage, discount, com= mission, profit and loss.

5. Simple interest. Compound interest (calculations limited to 3 periods).

6. A discussion of:

   (a) Rates and taxes, referring to local, provincial and income tax;

(b) monetary systems and rates of exchange;

(c) insurance and investments.

ALGEBRA

1. Application of the following laws of exponents (without proof) in their simplest form:

(a) $a^x \times a^y = a^{x+y}$

(b) $a^x \div a^y = a^{x-y}$ (where $x \geqslant y$)

(c) $(a^x)^y = a^{xy}$
(d) $(ab)^x = a^x b^x$

(where a, b, x and y are natural numbers).

2. Products of the following types by inspection:

(a) $m(a\pm b\pm c)$ (b) $(a\pm b)^2$

(c) $(a+b)(a-b)$ (d) $(a\pm b)(c\pm d)$

(e) $(ax\pm b)(cx\pm d)$

3. Simple factors of expressions of the following types:

(a) $ma\pm mb\pm mc$ (b) $c(a\pm b)\pm d(a\pm b)$

(c) $ax^2\pm bx\pm c$ (d) $a^2 - b^2$

(e) $a^3\pm b^3$

NB. In 2 and 3 above, m, a, b, c, and d represent rational numbers and x a single term. Compounding two or more factors of the above types excluded.

4. Finding the solution sets of simple equations and inequa= lities of the first degree with one unknown and rational coefficients. Graphical representation of such solution sets on the number line.

5. Changing the subject of a formula. Substitution.

6. Algebraic solution of simultaneous equations and inequa= lities of the first degree with two unknowns. Applica= tion to the solution of simple problems.

7. The properties and the n th term of an arithmetic sequence and a geometric sequence; formulae for the sum to n terms of arithmetic and geometric progressions; convergence of geometric progressions.

8. The solution of quadratic equations by means of factors.

GRAPHS

1. The function $y = mx + c$ and its graphical representation.

2. The function $y = ax^2 + bx + c$ and its graphical represen= tation.

GEOMETRY

1. An understanding of the following should be developed through a visual and an experimental approach:

   (a) Point, line, ray, line segment, perpendicular, parallel lines;

   (b) the circle;

   (c) different types of angles;

   (d) different types of triangles.

2. (a) The following constructions:

   (i) constructing and measuring line segments and angles;

   (ii) bisecting line segments and angles;

   (iii) constructing perpendiculars and parallel lines with the aid of a set square;

   (iv) constructing a triangle from any one of the following given sets of data:

   1. three sides;

   2. two sides and an included angle;

3. one side and two angles adjacent to it;

4. side, hypotenuse and the right angle.

(b) Drawing to scale, to include the following:

(i) clockwise angular bearings from the north;
(ii) compass bearings with reference to the N-S line;
(iii) angles of elevation and depression.

3. The properties of:

(a) triangles, with special reference to the right-angled triangle (Theorem of Pythagoras);

(b) parallelogram;

(c) circle, with special reference to the properties of the angles subtended by a chord.

4. The concept of locus and the construction of:

(a) the set of points equidistant from a given point;

(b) the set of points equidistant from a given line;

(c) the set of points equidistant from two given parallel lines;

(d) the set of points equidistant from two given points;

(e) the set of points equidistant from two given inter=secting lines;

(f) the set of points at which a given line segment sub=tends a right angle.

5. Congruency of triangles. A discussion of similarity.

6. The following theorems to be illustrated experimentally:

(a) If two lines intersect, the sum of any pair of adjacent angles is equal to 180°.

(b) When two lines intersect, the vertically opposite angles are equal.

(c) If a transversal intersects two parallel lines,

(i) the alternate angles are equal,

(ii) the corresponding angles are equal,

(iii) the sum of the interior angles on the same side of the transversal is 180°.

The converses of (i), (ii) and (iii) above.

(d) The sum of the three angles of a triangle is 180°.

(e) The four cases of the congruency of triangles.

(f) The base angles of an isosceles triangle are equal and the converse.

(g) The opposite sides and angles of a parallelogram are equal, the diagonals bisect each other and each diagonal bisects the area of the parallelogram.

(h) A parallelogram and a rectangle on the same base and between the same parallels have equal areas, with the following corollaries:

(i) the area of a parallelogram = base × height;

(ii) the area of a triangle = $\frac{1}{2}$ base × height;

(iii) the area of a trapezium = $\frac{1}{2}$ (sum of the parallel sides) × (the perpendicular distance between the parallel sides).

(i) The diagonals of a rectangle are equal to each other.

(j) The diagonals of a rhombus bisect each other at right angles and bisect the angles of the rhombus.

(k) The theorem of Pythagoras and its converse.

(l) The line joining the centre of a circle to the midpoint of a chord is perpendicular to the cord.

(m) The angle subtended by an arc at the centre of a circle is equal to twice the angle subtended by the arc at the remaining part of the circle. Proof on only one figure.

(n) The angles in the same segment of a circle are equal.

(o) The angle in a semi-circle is a right-angle.

METHOD

1. Diagnostic tests and remedial teaching.

2. The psychological principles underlying the teaching of arithmetic.

BACKGROUND STUDY

1. An assignment in arithmetic which demands reference work in the library.

2. The making of a more advanced piece of apparatus with the notes of a lesson in which this apparatus is used.

PRACTICE TEACHING

FIRST YEAR: Observation.

SECOND AND THIRD YEAR: A minimum of 2 lessons per student each year presented as criticism lessons.

EXAMINATION:

FIRST YEAR: An examination consisting of:

First Paper (Comprehension and calculation)	125 marks
Second Paper (Advanced Problems)	75 marks
Year's work	100 marks

SECOND YEAR: SENIOR COURSE

First Paper (Method and Problems)	125 marks
Second Paper (Method)	75 marks
Year's work	100 marks

THIRD YEAR:	First Paper:	Arithmetic	40 marks
		Algebra and Graphs	60 marks
		Geometry	40 marks
	Second Paper -	Method	60 marks
	Year's work		100 marks

The following textbooks are representative of those prescribed for the above compulsory Mathematics courses:

First Year: I.J.M. Archer, D.J. Hechter, J.A. van Zyl and C.R. Venter: Modern Basic Mathematics, Std 5. Maskew Miller, Cape Town, 1973.

Second Year: I.J.M. Archer, A.A. Gonin and G.P.L. Slabber: Modern Graded Mathematics for Std 6. Nasou, Cape Town, 1969.

Third Year: I.J.M. Archer, A.A. Gonin and G.P.L. Slabber: Modern Graded Mathematics for the Junior Certifi= cate. Nasou. Cape Town, 1969.

For Method the following textbooks are used:

A.L. Behr. The Teaching of the New Arithmetic. Nasou, Cape Town, 1968.

Cape Education Department: Teaching Guide.

Because of the fact that the above Mathematics courses are com= pulsory, no minimum entrance qualification to the courses are demanded. In order to enrol for the Primary Teachers' Diploma a person must be in possession of at least the Senior School Leaving Certificate. However, seeing that there are no admis= sion requirements as regards Mathematics, the compulsory Mathe= matics classes are heterogeneous in respect of mathematical background (see Par. 2.3).

3.3.3 Optional Mathematics Courses

As was mentioned in the previous paragraph, students may elect to prolong their course for a further year in order to specialise in two subjects of their choice. Students wishing to specialise in Mathematics must, however, have passed Mathematics at the Senior Certificate level before being allowed to specialise in Mathematics. The syllabus for the specialisation Mathematics course is not available at present as it is still being finalised. However, it is to be an integrated method and content course with the emphasis on content and 20 periods of thirty five minutes per week is set aside for the course. The following textbook is once again representative of the prescribed books that are used:

I.J. Archer, A.A. Gonin and G.P.L. Slabber: Modern Graded Mathematics for the Senior Certificate. Nasou, Cape Town, 1969.

3.3.4 Method Courses for Mathematics

There are no specific Method Courses as such. As has already been mentioned under the heading Compulsory Mathematics Courses, the compulsory courses in Mathematics are integrated content and method courses. In fact, point 6 under Remarks on the Mathematics syllabus for the Primary Teacher's Diploma for the senior standards (see 3.3.2 b) underlines the aim that content and method should be integrated throughout with the following guidelines concerning Method being given on page 5 of the syllabus:

Method: "1. The aim and value of Mathematics.

2. The contemporary approach to the teaching of Mathematics.

3. General principles of instruction in Mathematics.

4. Teaching aids: the nature and use of aids which will illuminate the subject matter; acquaintance with the construction of suitable apparatus (a limited number of these teaching aids may be made by the students themselves).

5. The methods of teaching the different sections of the syllabus for Std II to Std V.

6. Testing and evaluation of progress.

7. Diagnostic tests and remedial work."

As far as teaching practice is concerned the following appears on page 10 of the same syllabus:

"Practice Teaching:

First Year:	Observation.
Second and Third Year:	A minimum of 2 lessons per student each year presented as criticism lessons."

No indication of the actual time spent in the schools is given but this will, of course, comply with the regulations as laid down in the Criteria (37). Keeping in mind the research being done overseas, especially in the United States of America, (see Paragraph 5.1), over the importance of teaching practice, and the greater emphasis already being placed on this aspect of the teacher training programme in certain South African in= stitutions such as the Universities of Cape Town and Stellenbosch, the question arises whether the above-mentioned teaching prac= tice allotment is sufficient. No sign of new teaching practice approaches such as micro-teaching (mini-teaching) could be found (see Paragraph 5.1).

At present criticism lessons are evaluated by college lecturers visiting the schools during teaching practice, while the head= master of the school also gives a report in consulation with his staff on each student's total stay at his school. The form used by the lecturers in evaluating the students' criticism lessons differ from college to college but the form given in the appendix, Form A is representative of the form used.

A student who fails the subject Teaching Practice fails that specific year. The Teaching Practice mark is obtained by adding the criticism lessons marks for the various subjects in which the student did criticism lessons. In the second and third years this Teaching Practice mark constitutes roughly 12 per cent of the final year-mark and in the fourth year, 8 per cent.

3.4 THE TRAINING OF MATHEMATICS TEACHERS FOR THE PRIMARY SCHOOL IN NATAL

3.4.1 Introduction

As is the case in the other provinces of South Africa, the Col= leges of Education in Natal are also midway in the change from the old system to the new one as announced by the Minister of Education and embodied in the Education Policy Amendment Act (No. 73 of 1969). The result is that several courses are to be found at the Teachers' Training Colleges, some resorting under the old dispensation and others resorting under the new dis=

pensation. In order to gain some insight into the nature of the training of Mathematics teachers at the Colleges of Education in Natal, the position at the Durban College of Education will be described as being representative of the position under the Natal Education Department.

3.4.2 Compulsory Mathematics Courses

During 1973 all the third year students were following courses which resort under the old dispensation. These students must take General Mathematics which is a three-year course and pre= pared all aspirant teachers for the teaching of Mathematics (Arithmetic) up to about Std 4 level in the primary school. Although the General Mathematics Course was considered a compul= sory three-year course, in practice exemption from the course may be granted to third-year students who decided to specialise in certain other subjects, such as Art or Geography. The stan= dard of the course was roughly up to matriculation standard and included the method of teaching the subject, although the syl= labus did not give much indication as to the nature of the methodology.

The General Mathematics Course could be completely bypassed in one way only and that was by specialising in Mathematics. Stu= dents who felt so inclined then took the specialization course in Mathematics. This course was taken in all three years of the students' training. However, more will be said about this course under the next heading, Optional Mathematics Courses.

The above is a brief description of the present position with regard to the third-year student group finishing off their training under the old dispensation. As from 1974 the above arrangements will no longer exist, except possibly in a few cases where present third-year students decide to acquire better qualifications by completing a fourth year of study.

First and second-year students at all the provincial Colleges of Education in Natal resort under the new dispensation as an= nounced by the Minister of National Education, seeing that the new courses came into effect at the beginning of 1972. With regard to the training of Mathematics (Arithmetic) teachers for the primary school in Natal, the position is that all students enrolling for the Primary Teacher's Diploma are compelled to take General Mathematics. It is a three-year course and as far as can be ascertained, no exemption from this course is allowed. Where students wish to specialise in Mathematics, they simply take the additional courses which are not presented concurrently with the General Mathematics Courses.

The General Mathematics Course which all the students are com=pelled to take is of a higher standard than the old General Mathematics Course. It aims to reach at least matriculation standard as far as content is concerned and also includes the methodology of Mathematics. The mathematical content of the General Mathematics syllabus corresponds closely with that of the Orange Free State and, in contrast to the Transvaal's syllabuses, does not distinguish between the Junior Primary and Senior Primary courses.

The fact that Natal's General Mathematics Course is spread over three years and not two, as is the case in the Transvaal and the Orange Free State, has much to recommend it. Students often lose touch with any subject if they don't take it for a year and subsequently lose confidence in their use of it.

The following is the syllabus used in Natal for the three-year training course for primary school teachers:

"<u>NATALSE ONDERWYSDEPARTEMENT</u>
<u>ALGEMENE WISKUNDE</u>
<u>DRIEJARIGE KURSUS VIR ONDERWYSKOLLEGES</u>

1.00 <u>SAAMBINDENDE EN UNIVERSELE BEGRIPPE</u>

(L.W.: Al hierdie begrippe hoort gebruik te word slegs in soverre hulle nodig is vir verdere ontwikkelinge in die res van die leerplan. Hulle moet oral ingevoer word waar hulle begrip van die werk sal bevorder of waar hulle 'n benadering wat deurgaans t.o.v. die vak gebruik word, illustreer, of waar hulle dien as skakels tussen skynbaar onafhanklike afdelings. In latere besprekings van metodiek kan "saambindende en universele begrippe" as 'n afdeling bespreek word.)

Versamelings; grafiese werk (ingesluit die getallelyn); eksperimentering met voorwerpe; papiersny en vouwerk; wiskundige denke (probleemoplossing); effektiewe metodes van berekening; hoofrekene; toetsing van antwoorde; benaderings en skattings. Die opteken, klassifikasie, grafiese voorstelling en ontleding van gegewens.

2.00 <u>GETALLE</u>

(L.W. Spits toe op begripsvorming).

2.01 <u>Oorsig van die geskiedenis van getalle</u>

2.02 Telling: Ingesluit een-tot-een afbeelding van versame=lings. Gebruik konkrete voorbeelde en die getallelyn. Terme: kleiner as; groter as.

2.03 Heelgetalle: Ordinale en kardinale eienskappe; die getal nul.

2.04 Notasie: Kort geskiedenis, (Romeinse notasie ingesluit); plekwaarde; stelsels met grondtalle anders as 10.

2.05 Die vier bewerkinge:

(a) Aard van die bewerkinge: aard van optel en verme=nigvuldiging met verwysing na konkrete situasies; aard van aftrekking en deling - ingesluit die feit dat hulle inverse bewerkinge is van optelling en vermenigvuldiging.

(b) Basiese feite i.v.m. getalle: optelling en ver=menigvuldigingstafels, ingesluit reghoekige ordening; die onderrig van hierdie feite (sien Gagg); horison=tale en vertikale getalsinne; opesinne en die uitbreiding van die gebruik van simbole.

2.06 Basiese wette: Kommutatiewe, assosiatiewe en distribu=tiewe wette; wette van vermenigvuldiging met 1 en 0; wet vir die optel van 0; wette vir die vermenigvuldiging met 10 en veelvoude van 10 (en die vergelyking hiervan met stelsels met ander grondtalle).

2.07 Basiese prosedures: Geskrewe prosedure vir die vier bewerkinge (met verduideliking), ingesluit langdeling en vermenigvuldiging, optelling met "oordra" en die verskillende metodes van aftrekking (plekwaarde en die basiese wette is in hierdie afdeling belangrik) illus=treer met ander grondtalle; die terme: som, verskil, produk, kwosiënt.

2.08 Faktore: Faktorisering; reëls vir deelbaarheid van getalle; K.G.V. en die begrip G.G.F.; vermenigvuldig=ing en deling d.m.v. faktore.

2.09 Gerigte getalle: Uitbreiding van die getalbegrip om negatiewe getalle in te sluit; ongelykhede, ingesluit grafieke op die getallelyn.

2.10 <u>Breuke</u>: (L.W., gebruik konkrete voorbeelde en die getal=lelyn of ander grafiese voorstellings waar moontlik).

(a) <u>Gewone breuke:</u> breuke van voorwerpe; die kind se vroeë ondervinding van breuke; die betekenis van breuke; breuknotasie en die betekenis van die notasie; ekwivalente breuke; egte en onegte breuke; die vier bewerkinge soos uitgevoer met breuke, en 'n begrip van die betekenis hiervan, veral as 'n uit=breiding van die betekenis van bewerkinge uitgevoer met heelgetalle; die breuk as kwosiënt.

(b) <u>Desimale breuke:</u> hul verband met gewone breuke; plekwaarde; bewerkinge.

(c) <u>Persentasies:</u>

2.11 <u>Verhouding en eweredigheid:</u> Betekenis en gebruik van verhouding; betekenis en gebruik van eweredigheid; di=rekte en omgekeerde eweredighede en samestellings hiervan; 'n besef van die feit dat daar hoeveelhede is wat in ver=band staan tot mekaar, maar wat nie direk of omgekeerd eweredig aanmekaar is nie, (bv. lengte en ouderdom, buitemate en volume van 'n stel soliede liggame); ewe=redige deling; grafiese voorstelling van dele van hier=die afdeling.

2.12 <u>Gemiddeldes:</u>

3.00 <u>RUIMTE</u>

(L.W.: Bespreek natuurlike meet-eenhede sowel as stan=daardeenhede).

3.01 <u>Die begrip lengte:</u> Die meet van die lengte van reguit en krom lyne; natuurlike lengte-eenhede; standaard=eenhede.

3.02 <u>Eenvoudige vlakfigure:</u> Hoeke; basiese geometriese eienskappe; eenvoudige transformasies; simmetrie.

3.03 <u>Die begrip omtrek:</u> Praktiese benadering; berekening as vorm van tydsbesparing in sommige gevalle; praktiese bepalings van grafiese metodes ingesluit.

3.04 <u>Die begrip oppervlakte:</u> Vergelyking van oppervlakte (sonder eenhede); eenhede van oppervlakte; praktiese maniere om oppervlakte te meet; oppervlakte van reg= hoeke; parallelogramme, driehoeke, sirkels.

3.05 <u>Begrippe, volume en inhoud:</u> Die vergelyking van volumes (sonder eenhede); vergelyking van inhoud (sonder een= hede); eenhede van volume en inhoud; volumes van soliede reëlmatige liggame: kubus, reghoekige prisma, regte silinder, piramide, bol en kegel; eksperimentele bena= dering waar moontlik.

FISIESE GROOTTE

4.00 Geld, massa, inhoud, tyd, lengte, oppervlakte en volume; eenhede en die onderlinge verhoudings tussen hulle; die vier bewerkinge beperk tot die wat nie meer as twee verwante eenhede betrek nie, (voorbeelde moet uit werklike ervaring geneem word; sluit deling van die vol= gende soort in: "'n lengte deur 'n lengte", bv. hoeveel stukke, 4 cm. lank, kan gesny word van 'n lint 5 meter lank).

SOSIALE REKENKUNDE

5.00 Huishoudelike rekeninge. Begroting. Bankwese. Assu= ransie. Enkelvoudige rente. Ander geldstelsels. Be= lastings. Die lees van tabelle b.v. busdiensroosters, eenvoudige statistiese gegewens, sektorvoorstellings, prentjies- en grafiese voorstelling.

6.00 METODES VAN ONDERRIG

7.00 DIE LAERSKOOL SE LEERPLAN

'n Oorsig van doelstellings, inhoud en struktuur van die leerplan in die laerskool.

8.00 MODERNE NAVORSING EN NUWE RIGTINGS

Moderne rigtings; nuwe en interessante metodes; be= wegings en eksperimente aan die gang in ons land en die buiteland."

The following fourth-year syllabus is presented for students enrolled for the Natal Senior Teacher's Diploma:

"'n Vierdejaarkursus

1. Sielkundige agtergrond tot die Wiskunde-onderrig.

2. Metodiek van Wiskunde- en Rekenkunde-onderrig.

3. Algebra:

   (a) Elementêre Algebra soos in die standerd 6-, 7- en 8-leerplanne.
   (b) Logaritmes.

4. Rekenkunde soos in die standerds 6-, 7- en 8-leerplanne.

5. Meetkunde: Elementêre twee- en driedimensionele meetkunde soos in die standerds 6-, 7- en 8-leerplanne.

6. Trigonometrie soos in die standerds 7- en 8-leerplanne.

7. Eenvoudige Rekenhulpmiddels - skuifliniaal, tabelle, optel=masjiene, kompers.

8. Elementêre Statistiek: Grafiese voorstelling. Frekwensie. Modus, rekenkundige gemiddelde, mediaan. Gemiddelde afwy=king. Standaard afwyking. Verspreiding. Interpretasie.

9. Die maak van hulpmiddele."

3.4.3 Optional Mathematics Courses

Once again it is necessary to briefly describe the position of the third-year and fourth-year students at the Natal Colleges of Education under the old dispensation. The present third and fourth year students were given the choice of taking either General Mathematics or Pure Mathematics when they entered college in their first year. Both courses were of three years' duration and were offered concurrently so that it was not possible to take both. The Optional Mathematics Course included topics from Applied Mathematics and was actually aimed at pre=paring prospective secondary school teachers for the teaching of Mathematics up to Std 8. This Mathematics course aimed at bringing the students up to approximately first-year university standard, although it is not recognised as such for degree purposes by the universities. Students who wished to do so could stay at college for a fourth year and specialise further in Mathematics. In doing so these students would be on ap=proximately second-year university level on successfully com=

pleting the course and be considered qualified to teach Mathematics at secondary school up to Std 10. Unfortunately, only an interim syllabus for the second of the two courses, the fourth year course, was available. This syllabus is as follows:

"NATALSE ONDERWYSDEPARTEMENT

NATALSE SENIOR ONDERWYSERDIPLOMA

WISKUNDE

'n Nuwe Vierdejaarkursus vir 1972, 1973, 1974

1. Voltooiing van die werk nie in die derde jaar gedoen nie.

2. Algebra:

   'n Elementêre behandeling van komplekse getalle.
   'n Elementêre behandeling van transfiniete getalle.
   Boolse algebra - definisie; dualiteit; basiese stellings; orde.

3. Meetkunde: Eienskappe van kegelsnedes.

4. Calculus: Parsiële differensiasie
   Differensiasie en integrasie van vektore
   Toepassing van integrasie
   Eenvoudige differensiale vergelykings.

5. Elementêre Waarskynlikheidsleer en Statistiek.

6. Elementêre rekenhulpmiddels.

7. Metodiek van Wiskunde-onderrig."

Since the beginning of 1972 the position has changed. Whereas previously students had to choose between General Mathematics and Pure Mathematics, they now have to choose between General Mathematics and General Mathematics combined with Pure Mathematics. As has already been explained, every student takes General Mathematics and if he wishes to specialise in Mathematics, he takes Pure Mathematics over and above General Mathematics. However, students are only offered the Pure Mathematics course as from their second year of study so that only those students who have done well enough in General Mathematics during their first year are allowed to take Pure Mathematics as from their second year on. It will be noticed from the ensuing syllabus for this course that it is a purely mathematical content course. No teaching method is integrated with this course, the teaching method done in the General Mathematics course being considered sufficient for the Mathematics specia= lists as well.

The following is the syllabus for this course:

"NATALSE ONDERWYSDEPARTEMENT

NATAL SENIOR ONDERWYSDIPLOMA

W I S K U N D E

'n Driejaar Kursus

Hersiening van die skool Wiskunde.

Die volgende afdelings op die vlak van Wiskunde I aan die uni= versiteit:

Trigonometrie

Trigonometriese funksies van enige hoek. Optellingsteoremas Boogmaat. Maklike identiteite. Oplossing van trigonometriese vergelykings.

Algebra

Groepe en velde. Die reële getalstelsel. Versamelings, rela= sies en funksies. Kwadratiese vergelykings; die kwadratiese funksie; nulpunte van veelterme (algemene teorie sonder bewyse). Die resstelling. Permutasies en kombinasies. Die binomiale stelling vir positiewe reële integrale eksponente. Matematiese induksie. Rye en reekse. Somme Σr, Σr^2, Σr^3. Eksponente, wortelvorms, rasionalisering. Logaritmes, in= sluitende verandering in grondtalle bewys. Parsiële breuke (geen bewyse van eksistensieteoremas nie). Determinante van die tweede en derde orde. Matrikse - tot by die derde orde. Elementêre vektor - algebra. Elementêre behandeling van stelle van liniêre vergelykings.

Meetkunde

Cartesiese en pool koördinate. Reguit lyn en sirkel. Raaklyn aan sirkel.

Calculus

Limiete en kontinuïteit. Afgeleide as toestandsverandering Hoër afgeleides. Maksima, minima en buigpunte. Die trek van grafieke. Integraal as die limiet van 'n som en as die inverse van differensiasie. Differensiasie en integrasie van die ele= mentêre algebraïese en trigonometriese funksies. Integrasie deur vervanging en parsiële integrasie. Toepassing van integrasie op oppervlaktes, translasiebeweging en volumes van omwentelingsliggame.

Metodiek van onderwys van Wiskunde

Elementêre rekenhulpmiddels; skuifliniaal, tabelle, nomogramme, optelmasjiene, kompers.

Logika. Induksie en deduksie.

Elementêre Statistiek: grafiese voorstelling, frekwensie, modus, rekenkundige gemiddelde en mediaan, gemiddelde afwyking, stan= daard afwyking, distribusie."

3.4.4 Method Courses for Mathematics

As previously mentioned, there are no separate Method courses for Mathematics. The teaching method of the various topics are dealt with as the topics arise during the three-year Gene= ral Mathematics course. What exactly the nature of the lec= tures on the method of teaching Mathematics is, is impossible to say if one has to look at the General Mathematics Syllabus. Although the teaching method of the topics is dealt with as it arises, this is not indicated so in the syllabus, the only reference to method being four lines right at the end of the third year's syllabus, and a line or two in the fourth year's syllabus (see pages 108 and 109). The scheme of work for the General Mathematics Course offers nothing more: four lines in the introduction. Admittedly it is difficult to set out in any syllabus exactly how the presentation of each topic is put across to the students and in what way the students them= selves take active part in the development of an acceptable way of presenting specific topics. However, the danger does exist that "modern" mathematical topics will be treated in the same "age-old traditional manner" by lecturers if the teaching method is left entirely to each lecturer's judgment without him having to pay specific attention to methodology as set out in a syllabus.

3.5 THE TRAINING OF MATHEMATICS TEACHERS FOR THE PRIMARY SCHOOL IN THE ORANGE FREE STATE

3.5.1 Introduction

There is only one teachers' training college in the Orange Free State namely at Bloemfontein and it functions in close conjunc= tion with the University of the Orange Free State. As far as the training of Mathematics teachers for the primary school is concerned, the teachers' training college in Bloemfontein offers the Higher Primary Teaching Certificate (HPTC). Provision is made for a Junior Primary and a Senior Primary orientated training. The first two years of both courses are the same, but during their third year of study students specialise in one of the courses according to their choice. Either of the two direc= tions may be continued with for a fourth year of study during which emphasis is laid on subject teaching. In all respects, therefore, the position at the Bloemfontein Teachers' Training College corresponds to that of the Transvaal provincial colleges subject to the provisions of the Criteria (37).

3.5.2 Compulsory Mathematics Courses

During the first two years of study all the students enrolled for the Higher Primary Teachers' Certificate take a course in Arithmetic which includes methodology. Four thirty-five minute periods are allocated to this course for each of the two years. This compares favourably with the present position as regards the time allocated to the compulsory Mathematics (Arithmetic) course at teachers' training colleges in the Transvaal. As has already been stated, no Mathematics (Arith= metic) is done at the Transvaal teachers' training colleges during the students' first year of study while in the second and third years three and four periods are allocated respec= tively to Mathematics (Arithmetic). The syllabus used for the compulsory Mathematics course follows. Although the syllabus does not specifically indicate it, it is an integrated method course in which the teaching of the Mathematics content is emphasised.

"SILLABUS: O.V.S. HOËR PRIMÊRE ONDERWYSSERTIFIKAAT

WISKUNDE

EERSTE JAAR
(4 periodes)

1. Versamelingsleer

Die begrip versameling, elemente van 'n versameling, eindig en oneindige versamelings, een-eenduidige ooreenkoms, gelyke en ekwivalente versamelings, kardinaalgetal, die leë versameling, universele versameling, deelversameling.

Simbole en skryfwyse (versamelingskeurder-notasie inge= sluit).

Deursnee en vereniging van versamelings, disjunkte versa= melings, komplement van 'n versameling; die Cartesiese produk (kruisproduk) van twee versamelings.

Venn-diagramme, oplossing van eenvoudige probleme met behulp van Venn-diagramme.

2. Grafiese Voorstellings

Grafiese voorstellings word dwarsdeur die sillabus gebruik waar toepaslik en geskik.

2.1 Voorstelling van inligting deur middel van:

interessante voorstellings,
prentjiegrafieke,
balkgrafieke,
blokgrafieke,
kolomgrafieke,
gebroke lyngrafieke,
lyngrafieke,
sirkelgrafieke.

2.2 Grafiese voorstellings van oplossingsversamelings vir die relasies aangedui deur =, $>$, $<$ op die getallelyn.

2.3 Die getallevlak: Geordende pare.
Cartesiese vlak - asse, oorsprong, absis, ordinaat.
Voorstelling van geordende getallepare deur punte op die Cartesiese vlak.

2.4 Grafiese voorstelling van die verwantskap tussen twee veranderlike hoeveelhede op twee reghoekige asse.

2.5 Bespreking, vertolking en afleidings van reeds getekende grafieke.

3. <u>Getalle</u>

3.1 Beknopte historiese oorsig van syferskrifstelsels soos Sjinese, Romeinse, Egiptiese, Babiloniese en Hindo-Arabiese. Die grondtal 10 of tiendelige stelsel.
Die begrippe uitgebreide notasie, eksponensiële notasie en standaard notasie, en die skrywe en herleiding van getalle vanaf plaaswaarde notasie na ander notasies en andersom. Herleiding van baie groot en baie klein getalle na stan=daard notasie.

3.2 <u>Natuurlike getalle en Telgetalle</u>

3.2.1 Die getallelyn: voorstelling van bogenoemde ge=talle daarop. Orde en geslotenheid.
Die bewerkingswette: kommutatief, assosiatief, distributief.
Die eienskappe van 0 en 1.

3.2.2 Tel: gewoontetel, een-eenduidig tel, kardinaal tel, ordinaal tel.
Begrippe minder as, meer as, gelykaan, eweveel, groter as, kleiner as, langer as, korter as, ens.
Herkenning en aanleer van syfersimbole.
Die plaaswaarde begrip.

3.2.3 Die begrippe optelling en som.
Die aanleer van die basiese optelverbindings.
Optelling van meer as twee getalle en van getalle met twee of meer syfers.

3.2.4 Die begrippe aftrekking en verskil.
Aftrekking as inverse bewerking van optelling.
Aanleer van basiese aftrekverbindings.
Die begrippe aftrektal en aftrekker.
Aftrekking sonder ontbinding.
Aftrekking van getalle met twee of meer syfers met ontbinding.

3.2.5 Die vermenigvuldigingsbegrip en produk.
Die aanleer van die basiese vermenigvuldigingsver=bindings.
Uitbreiding op grondverbindings.
Kort vermenigvuldiging en lang vermenigvuldiging.

3.2.6 Die begrip deling en verwante begrippe van kwosiënt, deler, deeltal en res.
Deling as inverse bewerking van vermenigvuldiging.
Die aanleer van die grondverbindings by deling.
Uitbreiding op grond verbindings.
Kort deling en lang deling.

3.2.7 Grondtalle 5, 2 en 8, onderlinge herleiding en toe=passing van basiese bewerkings op eenvoudige voor=beelde.

3.2.8 Priemgetalle.
Die begrippe faktor, veelvoud, gemene faktor, gemene veelvoud.
Die skrywe van getalle as die produk van priem=getalle.
Reëls vir deelbaarheid.
Eksponensiële skryfwyse.
Bepaling van G.G.F. en K.G.V. van twee of meer getalle deur middel van priem faktore.
Praktiese toepassing van G.G.F. en K.G.V.

3.2.9 Begrip rekenkundige gemiddeldes en berekening daarvan.

3.2.10 Benadering tot die naaste 10, 100 en 1000.

3.2.11 Rye van bekende getalle; die bepaling van ont=brekende terme in 'n gegewe ry.

TWEEDE JAAR
(4 periodes)

1. Heelgetalle

Uitbreiding van die getalbegrip tot die versameling heel=getalle. Geslotenheid ten opsigte van optelling, vermenig=vuldiging en aftrekking.
Additiewe inverse.
Voorstelling op die getallelyn.
Die vier hoofbewerkings vir heelgetalle.
Die bewerkingswette.

1.1 Die Rasionale Getalle

Uitbreiding van die getalbegrip tot die versameling rasio= nale getalle.
Geslotenheid ten opsigte van die vier hoofbewerkings.
Resiprook.
Voorstelling op die getallelyn; orde; digheid van rasionale getalle.
Ontoelaatbaarheid van deling deur nul.

1.2 Gewone breukvorm

Begrip, skryfwyse en grafiese voorstelling.
Funksie van teller en noemer.
Egte breuk, onegte breuk en gemengde getal.
Ekwivalente breuke, herleiding en vereenvoudiging.
Die vier basiese bewerkings toegepas op gewone breuke.
Orde van basiese bewerkings en toepassing van die bewer= kingswette.

1.3 Desimale breukvorm

Begrip, skryfwyse en grafiese voorstelling.
Plekwaardes.
Die vier hoofbewerkings met spesiale beklemtoning van plekwaarde en bewerkingswette.
Herleiding van gewone breuke na desimale breuke en andersom.
Benaderings.
Die begrip van notasie vir repeterende desimale breuke.
Omvorming na gewone breuke.

1.4 Persentasievorm

Begrip, skryfwyse, grafiese voorstelling.
Herleiding van telgetalle, gewone breuke en desimale breuke na persentasies en andersom.
Berekening van 'n persentasie van 'n hoeveelheid, en die berekening van 'n hoeveelheid as 'n persentasie daarvan gegee is.
Berekening van hoeveelheid as 'n persentasie van 'n ander hoeveelheid.
Gebruik van persentasies vir vergelykingsdoeleindes en toepassings.
Persentasie vermeerdering en vermindering.

1.5 <u>Getallesinne</u>

Getallefrases en getallesinne.
Getallesinne waarin die simbole $=$, $\neq$, $>$, $<$, $\ngtr$ en $\nless$ gebruik word.
Waar en vals getallesinne.
Oop getallesinne.
Vervanging van woordsin met oop getallesin en andersom.
Oplossing van oop getallesin (vergelyking of ongelykheid).
Grafiese voorstelling van oplossingsversameling.
Oplossing van probleme met oop getallesinne.

2. <u>Verhouding en Eweredigheid</u>

2.1 Begrip verhouding.
Verdeling van 'n hoeveelheid in 'n gegewe verhouding.

2.2 Die begrip eweredigheid as twee verhoudings wat gelyk is.
Die begrippe eerste, tweede, derde en vierde eweredige.
Die begrip middeleweredige.

2.3 Oplossing van probleme met behulp van eweredighede.

2.4 Grafiese voorstelling van 'n direkte eweredigheid en van 'n omgekeerde eweredigheid.

2.5 Geordende eweredige versamelings.
Die bepaling van die onbekende in 'n geordende eweredige versameling.

3. <u>Handelstransaksies</u>

3.1 <u>Wins en verlies</u>

3.1.1 Wins en verlies, en wins- en verliespersent (uitgedruk as persentasie van beide kosprys en verkoopprys).

3.1.2 Probleme in verband met kosprys, verkoopprys as die wins- of verliespersent uitgedruk is as 'n persentasie van die kosprys en ook as dit uitgedruk is as 'n persentasie van die verkoopprys.

3.2 <u>Afslag of korting</u>

3.2.1 Begrippe merkprys en afslag of korting.
3.2.2 Afslag as 'n persentasie van die merkprys.

3.2.3 Probleme in verband met afslag, merkprys en ver=koopprys as die persentasie-afslag bekend is.

4. <u>Benoemde hoeveelhede</u>

4.1 <u>Geld</u>

4.1.1 Bekendstelling met die gangbare munte en R1-noot, R5-noot en R10-noot.

4.1.2 Gelykwaardigheid van muntstukke.

4.1.3 Uitkeer van kleingeld.

4.1.4 Skryfwyse van geldbedrae.

4.1.5 Die hoofbewerkings met geldbedrae.

4.2 <u>Lengte-eenhede</u>

4.2.1 Ongestandaardiseerde meeteenhede.

4.2.2 Gestandaardiseerde meeteenhede.

4.2.3 Praktiese kennismaking met meter(m), sentimeter (cm), millimeter (mm) en kilometer (km).

4.2.4 Die verband tussen die lengte-eenhede en herlei=ding van een eenheid na 'n ander.

4.2.5 Hoofbewerkings met lengte-eenhede.

4.3 <u>Massa</u>

4.3.1 Bekendstelling met massa-eenhede kilogram (kg), gram (g), milligram (mg) en metrieke ton (t).

4.3.2 Die verband tussen die massa-eenhede en herleidings van een na die ander.

4.3.3 Hoofbewerkings met massa-eenhede.

4.4 <u>Inhoud</u>

4.4.1 Ongestandaardiseerde eenhede soos koppies, bottels en blikkies.

4.4.2 Bekendstelling op praktiese wyse met gestandaar=diseerde eenhede liter (l), milliliter (ml) en kiloliter (kl).

4.4.3 Herleiding van een eenheid na 'n ander.

4.4.4 Hoofbewerkings met inhoudsmate.

4.5 Tyd

4.5.1 Praktiese ondervinding van tydsduur soos bv. van verjaarsdag tot verjaarsdag, skoolkwartale, skool=vakansies, skoolweke, dae, periodes in die skool.

4.5.2 Tydsduur van week, maand, jaar, dag, uur, minuut en sekonde.

4.5.3 Die name van die dae van die week en van die maande van die jaar.
Aantal dae in die verskillende maande.

4.5.4 Tydlees op horlosie.

4.5.5 Hoofbewerkings met tyd.

4.5.6 Berekening van tydsverloop tussen twee gegewe tyd=stipte, en van aantal dae tussen twee gegewe datums.

4.5.7 Internasionale tydstelsel en skryfwyse.

5. Vormleer

5.1 'n Beknopte oorsig van die ou metrieke stelsel.

5.2 Die Systѐme International D'Unités of SI.
Algemene bespreking van die samestelling van die SI en die gebruik en betekenis van die voorvoegsels milli- tot kilo-.
Bespreking van voorkeureenhede en nie-voorkeureenhede.
Eenhede van die SI:

Lengte eenhede : m, mm, (cm), km.

Oppervlakte eenhede : m^2, mm^2, (cm^2), km^2 en (hektaar).

Kubieke eenhede : m^3, mm^3, (cm^3).

Inhoud : l, ml, kl.

Massa : kg, mg, g, metrieke ton.

Tyd : s, min, h, d, a.

5.3 Kennis van die volgende begrippe moet aanskoulik eksperi= menteel ontwikkel word.

5.3.1 Punt, lyn, lynstuk, halflyn.

5.3.2 Bepaling van lengtes van lynstukke en tekening van lynstukke van gegewe lengtes.

5.3.3 Loodreg, loodlyn, horisontaal, vertikaal, ewewydige lyne.

5.3.4 Hoek en die verskillende soorte hoeke: skerp hoek, regte hoek, stomp hoek, gestrekte hoek, inspringen= de hoek, omwenteling, komplementêre hoeke en sup= plementêre hoeke, aanliggende hoeke.

5.4 Die graad as eenheid om hoeke te meet.

5.4.1 Meting van hoeke met gradeboog en tekening van hoeke van gegewe grootte.

5.5 Driehoek

5.5.1 Verskillende soorte driehoeke: skerphoekig, stomp= hoekig, reghoekig, gelykbenig en gelyksydig.

5.5.2 Praktiese ontdekking van die volgende:

(a) som van die mate van die hoeke van 'n drie= hoek;

(b) die maat van die buitehoek van 'n driehoek is gelyk aan die som van die mate van die nie- aangrensende binnehoeke;

(c) mate van hoeke teenoor gelyke sye;

(d) mate van hoeke van 'n gelyksydige driehoek.

5.6 Vierhoek

Ontwikkeling van eienskappe ten opsigte van sye, hoeke en hoeklyne deur middel van meting, rotasie, simmetrie, papiervou, ens. van die reghoek, vierkant, parallelogram, ruit, trapesium en die vlieër.

5.7 Oppervlakte en omtrek

5.7.1 Afleiding van die formules vir die oppervlakte en omtrek van die reghoek, die driehoek en toepas= sings.

5.7.2 Berekening van die oppervlakte van reghoekige figure.

5.8 Sirkel

5.8.1 Tekening van die sirkel met muntstukke of tou of boom van ronde blikke.
Trek van sirkel met passer.

5.8.2 Die begrip middelpunt, straal, middellyn, omtrek.

5.8.3 Bepaling van die verhouding van die middellyn en die straal tot die omtrek."

Comparing this compulsory Mathematics syllabus with that of the Transvaal it will be noticed that whereas the Transvaal has separate syllabuses for students enrolled for the Junior Primary and the Senior Primary courses, the Orange Free State makes no distinction between the Junior Primary and Senior Primary Courses. Both groups follow the same syllabus which is similar to that of the Senior Primary Course syllabus of the Transvaal. It is difficult to argue the merits of the two provinces' approach as regards the training of teachers for the Junior Primary classes in the schools: on the one hand the initial introduction young pupils receive to Mathematics is most important as far as their attitude to the subject is con= cerned, but on the other hand even Junior Primary teachers do need to have some depth in their mathematical background. However, the main consideration is probably the demand for teachers. The greater the shortage the more difficult it is to offer specialised courses.

On the whole the Orange Free State's compulsory Mathematics syllabus tends to concentrate more on the basic mathematical content with few modern topics included. In contrast the Transvaal's compulsory Mathematics syllabus impresses with its Enrichment Programme where topics such as the History of Mathe= matics, Number Puzzles, Planning a Mathematics Workshop and Simple Computing Machines cannot be recommended enough. A spokesman at the Orange Free State's Teachers Training College did mention that for the sake of further background and depth, further work, especially in Algebra, was done out of A.P. Malan and E.C. Smith's "Modern Mathematics for Schools, Book I". Cotton and Hardie, Cape Town, 1967.

3.5.3 Optional Mathematics Courses

At the Teachers' Training College of the Orange Free State Senior Primary students may choose to specialise in the teaching of Mathematics at the end of their second year of study. In contrast to the practice in the Transvaal, where the speciali= zation course in Mathematics is strictly laid down, the Orange Free State offers two specialization courses in Mathematics each of which is spread over two years of study, namely during the third and fourth years of study. The first of these courses, the A-course, is the more difficult of the two and there is attempted to reach first-year university level. This course was originally planned for secondary school teacher training and was drawn up in close co-operation with the Mathematics Department of the neighbouring university. Ten thirty-five minute periods per week are allocated to this course for each of the two years of its duration. Once again, however, this course is not recognised for degree purposes.

The second of the two specialization courses, the B course, is not of such a high standard as the A course and is offered mainly to encourage as many students as possible to gain a further background in Mathematics. During the first of the two years of the course the students follow a Mathematics course adapted from the semester course in Mathematics offered to Commerce students enrolled for the Bachelor of Commerce degree at the neighbouring university. During the second year of this B course, students follow a Mathematics course adapted from the semester course in Mathematics offered to Statistics students at the neighbouring university. The syllabuses for these two courses A and B are as follows:

a. A Course

"DERDE JAAR
(10 periodes)

(A. KURSUS)

(L.W. (a) Die taal en notasie van versamelings behoort, waar toepaslik, deurgaans gebruik te word.

(b) Waar die universum nie gespesifiseer word nie, word die versameling reële getalle veronderstel.

(c) Geen punt vir punt tekening van grafieke word vir eksamendoeleindes vereis nie.

(d) Enige matematies geldige oplossing vir 'n probleem is aanvaarbaar.)

1. ALGEBRA

1.1 Versamelings

Vlugtige herhaling van die basiese begrippe soos in die st. VIII-leerplan vervat.

1.2 Die getalsbegrip

1.2.1 Saaklike hersiening van die (intuïtiewe) uit= breiding van die getalsbegrip tot en met die reële getalle.

1.2.2 Definisie van 'n groep. Optelling- en vermenig= vuldigingsgroepe binne die verskillende getalle= sisteme. Eenvoudige groepe, insluitend eindige strukture, nie-numeriese bewerkings en modulo-rekenkunde.

1.2.3 Definisie en herkenning van 'n liggaam in getal= lesisteme. Eenvoudige liggame insluitende modulo-rekenkunde.

1.3 Funksies

1.3.1 Afbeelding, voorskrif, formule, een- en meer= duidige afbeeldings, relasies en funksies, gebied en terrein, veranderlike, afhanklike veranderlike, onafhanklike veranderlike.

1.3.2 Inverse van funksies soos gedefinieer deur

$y = ax + b$, $y = ax^2$ en $y = a(x + p)^2$.

1.3.3 Die kwadratiese uitdrukking $ax^2 + bx + c$ en sy

omsetting na $a(x + p)^2 + q$.

1.3.4 Funksie van 'n funksie (relasie).

1.3.5 Grafiese voorstelling van relasies, insluitend voorbeelde van relasies gedefinieer deur verge= lykings (met rasionale koëffisiënte) van hoogstens die tweede graad; simmetrie, ligging en snypunte met die asse.

1.3.6 Spesiale aandag aan die volgende relasies:

$\{(x\ ;\ y)/ax + by + c = 0,\}$

$\{(x\ ;\ y)/x^2 + y^2 = r^2\}$,

$\{(x\ ;\ y)\ /y = ax^2 + bx + c\}$,

$\{(x\ ;\ y)/xy = k\}$, en absolute waardes soos

$\{(x\ ;\ y)/y = /ax + b/\}$ waar x en y reële verander= likes voorstel. Die afleiding van elkeen se kenmerke uit vergelyking t.o.v. gebied, terrein, snypunte met asse, ligging, simmetrie; hulle grafiese voorstelling.
Die gradiënt van 'n reguit lyn.

1.3.7 Gelykheids- en ongelykheidsbetrekkinge tussen relasies uit 1.3.6 insluitend.

$\{(x\ ;\ y)\ /y \gtreqless \sqrt{r^2 - x^2}\}$;

$\{(x\ ;\ y)\ /\ y \gtreqless -\sqrt{r^2 - x^2}\}$;

$\{(x\ ;\ y)\ /y \gtreqless \frac{k}{x}\}$;

$\{(x\ ;\ y)\ /\ y \gtreqless /\ ax + b/\}$

1.4 Kwadratiese vergelykings

1.4.1 Die wortels van $ax^2 + bx + c = 0$; die aard van die wortels; die som en die produk van die wortels.

1.4.2 Die oplossingsversameling $\{x / ax^2 + bx + c \gtrless 0\}$.

1.4.3 Oplossing van twee gelyktydige vergelykings waar= van een van die eerste en een van die tweede graad is.

1.4.4 Probleme wat lei tot die oplossing van kwadratiese vergelykings en ongelykhede van voorgaande tipes.

1.5 Eksponente

(L.W. Vir die bewyse van wette moet die grondtal positief wees.)

1.5.1 Definisie van a^n vir n 'n natuurlike getal, met afleiding van die wette:

$$a^m . a^n = a^{m+n}$$

$$a^m \div a^n = a^{m-n} \text{ vir } m > n \text{ of } \frac{1}{a^{n-m}} \text{ vir } m < n.$$

$$(ab)^n = a^n b^n$$

$$(a^m)^n = a^{mn}$$

1.5.2 Uitbreiding van eksponente na nul, negatiewe heelgetalle en rasionale getalle met die vereiste definisies,

nl. $a^0 = 1$, $a^{-n} = \frac{1}{a^n}$ $(a^{p/q})^q = a^p$.

en die bewyse vir die geldigheid van bogenoemde wette.

1.5.3 Verband tussen wortelvorme en eksponente en skryfwyse van die ooreenstemmende grondeienskappe:

$$\sqrt[n]{a} \cdot \sqrt[n]{b} = \sqrt[n]{ab}\ ; \quad \sqrt[m]{\sqrt[n]{a}} = \sqrt[mn]{a}\ .$$

$$\left(\sqrt[m]{a}\right)^n = \sqrt[m]{a^n}\ .$$

1.6 Logaritmes

1.6.1 Die eksponensiaalfunksie gedefinieer deur $y = a^x$, $a > 0$; sy ligging, vorm en grafiek; afleidings uit die grafiek.

1.6.2 Die logaritmiese funksie gedefinieer deur $y = \log_a x$, $a > 0$ en $a \neq 1$, as inverse van die eksponensiaalfunksie gedefinieer deur $y = a^x$; sy kenmerke en grafiek; afleidings uit die grafiek.

1.6.3 Afleidings uit die grafieke van die twee funk= sies.

1.6.4 Afleidings van die grondeienskappe van logaritmes.

1.6.5 Verandering van grondtal.

1.6.6 Gebruik van logaritmiese tafels soos benodig by toepaslike berekenings.

2. SINTETIESE MEETKUNDE

(L.W. Alhoewel alle stellings bewys moet word, word vir eksamendoeleindes slegs bewyse verlang van die stellings in onderstaande lys wat met 'n sirkeltjie aangedui is (en van hulle omgekeerdes, waar gemeld). Toepassings kan egter oor enige definisie, aksioma of stelling in hierdie lys gevra word. Nie meer as een-vyfde „boekwerk" sal vir eksamendoel= eindes vereis word nie.)

°2.1 Die verbindingslyn van die middelpunt van 'n sirkel en die middelpunt van 'n koord is loodreg op die koord, en omgekeerd. (Stelling.)

°2.2 Die hoek wat 'n boog van 'n sirkel in die middelpunt onderspan, is dubbel die hoek wat dit in 'n punt van die omtrek onderspan. (Stelling.)

2.3 Die hoek in 'n halwe sirkel is 'n regte hoek. (Stelling.)

2.4 Hoeke in dieselfde sirkelsegmente is gelyk, en omgekeerd. (Stelling.)

°2.5 Die som van 'n paar oorstaande hoeke van 'n koordevierhoek hoek is 180°, en omgekeerd. (Stelling.)

2.5.1 Die buitehoek van 'n koordevierhoek is gelyk aan sy teenoorstaande binnehoek. (Afleiding.)

2.6 Driehoeke (parallelogramme) op dieselfde basis (of gelyke basisse) en tussen dieselfde ewewydige lyne is gelyk in oppervlakte, en omgekeerd. (Stelling.)

2.7 Definisie van gelykvormigheid.

2.8 Enige lyn ewewydig aan een sy van 'n driehoek verdeel die ander twee sye eweredig, en omgekeerd. (Stelling.)

2.9 Ooreenkomstige sye van gelykhoekige driehoeke is eweredig, en omgekeerd. (Stelling.)

°2.10 Die stelling van Pythagoras, en omgekeerd.

2.11 Definisie van 'n raaklyn as die limietstand van 'n veranderlike snylyn wanneer die twee snypunte tot saam=valling nader.

2.12 'n Reguit lyn deur enige punt van 'n sirkel loodreg op die straal na daardie punt, is 'n raaklyn aan die sirkel, en omgekeerd. (Stelling.)

°2.13 Die hoeke tussen 'n raaklyn aan 'n sirkel en 'n koord deur die raakpunt is gelyk aan die hoeke in die oorstaande segmente, en omgekeerd. (Stelling.)

°2.14 As 'n snylyn en 'n raaklyn van 'n punt buite 'n sirkel aan die sirkel getrek word, is die kwadraat van die raak=lyn gelyk aan die produk van die segmente van die snylyn. (Stelling.)

°2.15 As twee koorde van 'n sirkel binne of buite die sirkel sny, is die produk van die segmente van die een gelyk aan die produk van die segmente van die ander. (Stelling.)

2.16 Die halveerlyne van die binnehoeke van 'n driehoek gaan deur een punt. (Stelling.)

2.17 Die middelloodlyne van die sye van 'n driehoek sny mekaar in een punt. (Stelling.)

2.18 Die mediane van 'n driehoek sny mekaar in een punt. (Stelling.)

2.19 Die hoogtelyne van 'n driehoek sny mekaar in een punt. (Stelling.)

3. DRIEHOEKSMETING

3.1 Definisie van die ses trigonometriese verhoudings m.b.v. koördinate.

3.2 Afleiding van onderlinge betrekkinge tussen die trigo= nometriese verhoudings vir 'n willekeurige hoek.

3.3 Afleiding van die gebied, terrein, vorm, ligging en periodisiteit van die sin-, cos- en tanfunksie. Sketse van die krommes van die genoemde sirkelfunksies. (Ook vir saamgestelde hoeke.)

3.4 Funksiewaardes vir 0°, 30°, 45°, 60° en 90°.

3.5 Funksiewaardes vir $180^{\circ} \pm \theta$, $360^{\circ} \pm \theta$ en $\theta \pm k \times 360^{\circ}$ vir $k = \pm 1, \pm 2, \pm 3, \ldots$ uitgedruk in terme van θ.

3.6 Afleiding van die sinusreël, cosinusreël en die formule $\frac{1}{2}ab\sin C$ vir die oppervlakte van 'n driehoek ABC. Op= lossing van driehoeke en probleme in die verband in twee en drie dimensies.

3.7 Identiteite

3.7.1 Betrekkinge tussen verskillende trigonometriese verhoudings.

3.7.2 Fundamentele identiteite gebaseer op die stelling van Pythagoras.

3.7.3 Bewys van die identiteit cos $(\alpha - \beta) = \cos\alpha \cos\beta + \sin\alpha \sin\beta$, en afleiding van identiteite vir cos $(\alpha + \beta)$, sin $(\alpha \pm \beta)$ tan $(\alpha \pm \beta)$ cos $(90^o \pm \theta)$, sin $(90^o \pm \theta)$, cos 2θ, sin 2θ en tan 2θ.

3.8 Algemene oplossings van eenvoudige trigonometriese ver= gelykings.

3.9 Die inverse relasies van die sin-, cos-, en tan-funksies. Beperking van die definisiegebied van die direkte funk= sies om hulle inverse funksies te maak."

b. <u>B Course</u>

"<u>DERDE JAAR</u>
(10 periodes)

<u>(B. KURSUS)</u>

1 Die begrippe vierkant en vierkantswortel.
Bepaling van die vierkantswortel van 'n getal deur middel van faktore, deur opeenvolgende benaderings en deur die deelmetode.
Gebruik van tabelle (tafels) om vierkantswortels van getalle te vind.

1.1 Derdemagte en derdemagswortels slegs deur faktore.

1.2 <u>Irrasionale getalle</u>
Vierkantswortels van getalle wat nie volkome kwadrate is nie deur middel van benadering en deelmetode.
Uitbreiding van die getalbegrip na irrasionale getalle en die voorstelling daarvan op die getallelyn.

1.3 <u>Reële getalle</u>
Samevatting van die getalbegrippe (natuurlike getalle; telgetalle, heelgetalle, rasionale getalle en irrasio= nale getalle) soos uitgebrei om 'n geheelbeeld van die getallestruktuur te vorm.

2 <u>Vormleer</u>

2.1 Die volgende konstruksies (met liniaal, gradeboog, passer en tekendriehoek):

2.1.1 Halvering van lynstukke en hoeke.
2.1.2 Die konstruksie van 'n hoek kongruent aan 'n gegewe hoek.
2.1.3 Konstruksie van loodlyne en ewewydige lyne.
2.1.4 Die konstruksie van 'n driehoek as die volgende bekend is:
(a) die mate van twee sye en die ingeslote hoek;
(b) die mate van een sy en die twee aangrensende hoeke;
(c) die mate van drie sye;
(d) die mate van die skuinssy en een reghoeksy van 'n reghoekige driehoek.
2.1.5 Meting en konstruksies in verband met snydende en ewewydige lyne.

2.2 Die kongruensie van driehoeke.

2.3 Pythagoras se stelling met toepassings.

2.4 Verband tussen oppervlaktes van:
(a) driehoeke met gelyke basisse en gelyke hoogtes;
(b) 'n driehoek en 'n parallelogram met gelyke basisse en gelyke hoogtes,
(c) parallelogramme met gelyke basisse en hoogtes.

2.5 <u>Die Sirkel</u>

2.5.1 Die begrip boog, koord, sektor, segment, opper= vlakte.
2.5.2 Afleiding van die formule vir die oppervlakte.
2.5.3 Berekenings in verband met omtrek en oppervlakte van die sirkel.
2.5.4 Tekening van sirkelpatrone.

2.6 <u>Skaaltekenings</u>

Skaaltekenings wat die volgende insluit:

2.6.1 regsom-graderigtings met betrekking tot die noord-rigting;
2.6.2 kompasrigtings ten opsigte van die N-S lyn;
2.6.3 hoogte- en dieptehoeke.

2.7 <u>Poliëders</u>

2.7.1 Regte prismas en piramiedes.
Die konstruksie van hierdie liggame uit karton.

2.7.2 Berekening van die buite-oppervlaktes van reg=hoekige prismas, 'n kubus, 'n prisma met drie=hoekige basis en 'n soliede silinder.

2.7.3 Begrip volume en volume-eenheid. Berekening van die volumes van 'n reghoekige prisma, 'n prisma met driehoekige basis, 'n soliede silinder.

3. Algebra

3.1 Inleiding tot die simboliese taal van die Algebra deur die voorstelling van rasionale getalle met plekhouers of lettersimbole.

3.2 Betekenis van veranderlike, konstant, koëffisiënt, faktor, term, uitdrukking, gelyksoortig en ongelyksoortige terme, veelterm, graad van veelterm, dalende of stygende magte.

3.3 Gebruik van hakies en hulle verwydering, met verwysing na die kommutatiewe, assosiatiewe en distributiewe wette.

3.4 Berekening van getalwaardes deur vervanging in eenvoudige uitdrukkings en formules.

3.5 Die begrippe eksponent, grondtal en mag.

Die eksponentwette: $a^m \times a^n = a^{m+n}$

$$a^m \div a^n = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

waar m en n natuurlike getalle is.

3.6 Hoofbewerkings met algebraïese uitdrukkings.

3.7 Produkte deur inspeksie van die volgende tipes:

$$m(a \pm b \pm c)$$

$$(a \pm b)^2$$

$$(c \mp b) \quad (a - b)$$

$$(x \pm a) \quad (x \pm b)$$

3.8 Eenvoudige faktore van die volgende tipes:

$$ma \pm mb \pm mc$$

$$c(a \pm b) \pm d(a \pm b)$$

$$ax^2 \pm bx \pm c$$

$$a^2 - b^2$$

3.9 K.G.V. en G.G.F. (slegs deur middel van faktore) en mak=like gevalle van vereenvoudiging van breuke.

3.10 Oplossing van lineêre vergelykings en ongelykhede met een veranderlike.
Grafiese voorstelling van oplossingsversamelings op 'n getallelyn.
Oplos van probleme met behulp van lineêre vergelykings.

3.11 Oplossing van twee gelyktydige lineêre vergelykings met twee onbekendes.
Grafiese bepaling van die oplossingsversameling van twee lineêre vergelykings met twee veranderlikes. Toepassing in die oplossing van eenvoudige woordprobleme.

4. Ontwikkeling van $k(a + b) = ka + kb$ en omgekeerd.

Ontwikkeling van $(a + b)^2$ en $(a + b)^3$.

Σ-notasie: $\sum_{i=1}^{n} a_i = a_1 + a_2 + a_3 + \ldots\ldots + a_n$

5. <u>Eksponente</u>

Bewerkings: $a^m \times a^n = a^{m+n}$

$$a^m \div a^n = a^{m-n}$$

$$(a^m)^n = a^{mn}$$

$$(ab)^n = a^n b^n$$

Afleidings: $a^0 = 1$

$$a^{-n} = \frac{1}{a^n}$$

$$a^{1/n} = \sqrt[n]{a}$$

$$a^{m/n} = \sqrt[n]{a^m}$$

6. <u>Logaritmes</u>

Getalle in standaardvorm bv. 0,032 76 = $3,276 \times 10^{-2}$
Definisie van logaritme: As enige getal N geskryf kan word as $N = a^x$, dan word x die logaritme van N met grondtal a, genoem of kortliks $x = \log_a N$

Gewone logaritmes (grondtal 10).
Natuurlike logaritmes (grondtal e).
Reëls vir bewerkings met logaritmes:
(i) die logaritme van 'n produk
(ii) die logaritme van 'n kwosiënt
(iii) die logaritme van 'n mag.

Aanwyser en mantissa.
Bepaling van 'n logaritme. Gebruik van tabelle.
Antilogaritmes. Gebruik van tabelle.
Interpolasie. (om tussen waardes te verkry).
Berekenings met logaritmes: eenvoudige sowel as same=gestelde vorme. Voorbeelde.

7. <u>Eenvoudige Reekse</u>

Definisie van 'n reeks.
Terme van die reeks.
Opstel van reekse as enkele terme gegee word.
Bepaling van die n-de of algemene term.
Gee n-de term, vind ander terme.

Rekenkundige reekse:	Definisie
	Algemene vorm, eerste term, gemene verskil.
	Som van n terme van R.R.
Meetkundige reekse:	Definisie.
	Algemene vorm, rede.
	Som van n terme van M.R.
Oneindige reekse:	Som van oneindige reekse.
	Som tot oneindig.

Som van magte van natuurlike getalle:

$$1 + 2 + 3 + 4 + \dots + n = \sum_{r=1}^{n} r$$

$$1^2 + 2^2 + 3^2 + 4^2 + \dots + n^2 = \sum_{r=1}^{n} r^2$$

$$1^3 + 2^3 + 3^3 + 4^3 + \dots + n^3 = \sum_{r=1}^{n} r^3$$

Toepassings:

$$\sum_{r=1}^{n} r(r+1) = \sum_{r=1}^{n} r^2 + \sum_{r=1}^{n} r$$

bv. $1 \times 12 + 2 \times 13 + 3 \times 14 + 4 \times 15 + \dots + 10 \times 21$

$$= \sum_{r=1}^{10} r(r+11) = \sum_{r=1}^{10} r^2 + 11 \sum_{r=1}^{10} r$$

8. <u>Beleggings</u>

Leen en uitleen van geld. Winsmotief.
Finansiële instellings: banke, bouverenigings, e.a.

<u>Grondbegrippe:</u>

Kapitaal.
Rente: agternabetaalbaar: enkelvoudig en samegesteld.
Vooruitbetaalbaar: enkel=voudige diskonto.

Eindbedrag.
Termyn.
Rente-omsettingsperiode.
Rentekoers.
Grondbeginsel: Geld verdien steeds rente sodat die waarde van 'n bedrag afhang van die tyd.

9. <u>Verhoudings</u>

A. Kommissie: Doel.
Berekening van bedrag, netto opbrengs, kommissie koers, bedrag waarop kommissie bereken word.

B. Korting: Doel.
Berekening op fabrieks-, groothandel-, kospryse, merkpryse en verkooppryse met of sonder korting.

C. Diskonto: $K = S - D$

$= S - Std$

$= S(1 - td)$

Berekening van diskonto, huidige waar= des, sigwaarde, termyn, diskonto koers. Verband tussen diskonto (vooruitbetaal= bare rente) en (agternabetaalbare) rente.

$$i = \frac{d}{1 - d} \quad \text{of} \quad d = \frac{i}{1 + i}$$

Bankdiskonto.

D. Waardevermindering: Reguit lyn en vaste persen= tasie metodes.

10. Belastings

Aan plaaslike owerhede: erfbelasting, saniteitsbelasting.
Aan sentrale owerhede: inkomste belasting (slegs indivi= due).
Koopbelasting.
Heffings (bv. water, elektrisiteit).
Berekenings op bogenoemde aan hand van eenvoudige voor= beelde.
(Slegs direkte berekenings).

11. Rente

Def. van rente, rentekoers.
Verskil tussen rente en dividend.
Rente-omsettingsperiode, kontantwaarde, eindwaarde.
Enkelvoudige rente: $S = K + R$
$= K + Kti$
$= K(1 + it)$
Berekening van enige een uit S, K, t en i as ander drie gegewe.
Bepaling van termyn (in dae), datum.
Variërende rentekoers.
Vol jare + breuke van jaar.
Akkumulasiefaktor $(1 + it)$
Samegestelde rente: $S = K(1 + i)^n$
Berekening van S, n en i deur gebruik te maak van Tabel I: Rentetabelle.

Berekening van K: Tabel II.
Akkumulasiefaktor $(1 + i)^n$.
Verdiskonteringsfaktor $(1 + i)^{-n}$.

12. <u>Versekering</u> (5-6 periodes)

Doel: dekking.
Avery klousule.
Soorte.
Berekening van premies teen vaste persentasie.

13. <u>Wissels en promesses</u> (5-6 periodes)

Gebruik van wissels in praktyk.
Akseptering van 'n wissel.
Opstel en trek van binnelandse wissels.
Verdiskontering van wissels by banke.

14. <u>Vennootskappe en maatskappye</u> (5-6 periodes)

Doel: Totstandkoming.
Samestelling van elk: ooreenkomste en verskille.
Private en publieke maatskappye.
Verdeling van wins en verlies in geval van vennootskappe.

15. <u>Insolvensies</u> (Bankrotskappe) (5-6 periodes)

Gewone en voorkeureise.
Dividende."

"<u>VIERDE JAAR</u>
(10 periodes)

<u>(A-KURSUS)</u>

A. <u>ALGEBRA</u>

1. <u>Versamelings</u>

1.1 Konsolidering van die versamelingsbegrip (intuïtief).
1.2 Deelversamelings; gelyke versamelings; die leë versa= meling.
1.3 Deursnede; vereniging; komplement.
1.4 Die assosiatiewe, kommutatiewe en distributiewe wette. De Morgan se wette. Venn-diagramme.

1.5 Die Cartesiese produk van versamelings.
1.6 Binêre bewerkings gedefinieer op versamelings.
1.7 Die basiese kenmerke van 'n deduktiewe sisteem.
1.8 Definisie en eenvoudige voorbeelde van groepe, ringe en liggame.

2. <u>Die getalsbegrip</u>

<u>Opmerking:</u> Hierdie kursus behels nie 'n streng matematiese uitbreiding van die getalsbegrip nie. Uit die definisies van bewerkings wat in so 'n opbou geformuleer word, word die resultate wat hieronder as <u>aksiomas</u> aangegee word as stellings afgelei. Hierdie aksiomas vorm dan telkens teen die agtergrond van 'n intuïtiewe kennis van die vorm van die onderhawige getalle die <u>definisie</u> van die betrokke getalle-sisteem.

2.1 Die sisteem $(N, +, \times)$ van natuurlike getalle.

2.1.1 Peano se karakterisering van die versameling N van natuurlike getalle.
2.1.2 Onderstaande aksiomas as definisie vir die sisteem $(N, +, \times)$ van natuurlike getalle.

N.1. Die assosiatiewe wette.
N.2. Die kommutatiewe wette.
N.3. Die bestaan van 'n vermenigvuldigingsidentiteit in N.
N.4. Die distributiewe wet.

2.2 Die sisteem $(Z, +, \times)$ van heelgetalle.

2.2.1 Die ringaksiomas vir die sisteem $(Z, +, \times)$.
2.2.2 Elementêre eienskappe van die ring $(Z, +, \times)$.
2.2.3 Definisie van aftrekking in $(Z, +, \times)$.

2.3 Die sisteem $(Q, +, \times)$ van rasionale getalle.

2.3.1 Die liggaamsaksiomas vir die sisteem $(Q, +, \times)$.
2.3.2 Elementêre eienskappe van die liggaam $(Q, +, \times)$.
2.3.3 Definisie van aftrekking en deling in $(Q, +, \times)$.

2.4 Die sisteem $(R, +, \times)$ van reële getalle.

2.4.1 Die liggaamsaksiomas vir die sisteem $(R, +, \times)$.
2.4.2 Elementêre eienskappe van die liggaam $(R, +, \times)$.
2.4.3 Definisie van aftrekking en deling in $(R, +, \times)$.

2.4.4 Irrasionale getalle en worteltrekking in $(R, +, \times)$. (Verwys na „Analise", 5.5).

2.5 Die sisteem $(C, +, \times)$ van komplekse getalle.

2.5.1 Definisie van die sisteem $(C, +, \times)$.
2.5.2 $(C, +, \times)$ is 'n liggaam.
2.5.3 Elementêre eienskappe van die liggaam $(C, +, \times)$.
2.5.4 Die normaalvorm van 'n komplekse getal.
2.5.5 Die ses bewerkings in $(C, +, \times)$ en rekenkunde in terme van die normaalvorm.

3. <u>Rye en Reekse</u>

3.1 Die beginsel van matematiese induksie.
3.2 Rye as funksies $f : N \to R$. Die algemene term.
3.3 Rekenkundige en meetkundige reekse.

3.3.1 Somme tot n terme.
3.3.2 Rekenkundige en meetkundige gemiddeldes.
3.3.3 Die konvergensie van oneindige meetkundige reekse.

3.4 Die eindige reekse $\sum_{r=1}^{n} r$, $\sum_{r=1}^{n} r^2$, $\sum_{r=1}^{n} r^3$.

Toepassings by die sommering van eenvoudige reekse.

4. <u>Permutasies en Kombinasies</u>

4.1 Definisie van permutasies as bijeksies. Definisie van kombinasies.
4.2 Die fakulteitsnotasie; uitdrukking vir ${}^nP_r$ en ${}^nC_r$; die definisie van 0!
4.3 Die betrekking ${}^{n-1}C_{r-1} + {}^{n-1}C_r = {}^nC_r$. Elementêre voorbeelde.

5. <u>Veelterme en vergelykings</u>

5.1 Veelterme met koëffisiënte in C.
5.2 Rasionale integrale funksies.
5.3 Basiese resultate.

5.3.1 Die delingsalgoritme vir veelterme (sonder bewys).
5.3.2 Die resstelling.
5.3.3 Die faktorstelling.

5.3.4 Die fundamentele stelling van die algebra (sonder bewys).
5.3.5 Die nulpuntstelling.

5.4 Ontbinding in parsiële breuke van rasionale breuke met koëffisiënte in R.
5.5 Die binomiaalstelling vir 'n positiewe heel eksponent.

5.5.1 Bewys deur induksie.
5.5.2 Die algemene term in die ontwikkeling.
5.5.3 Uitbreiding na $(x + y + z)^n$
5.5.4 Reekse in terme van binomiaal-koëffisiënte.

B. <u>VEKTOR-ALGEBRA EN TOEPASSINGS</u>

1. <u>Die twee- en drie-dimensionele vektorruimtes R_2 en R_3.</u>

1.1 Basiese begrippe.

1.1.1 Definisie van 'n vektor as 'n entiteit met grootte, rigting en rigtingsin.
1.1.2 Meetkundige voorstelling van vektore.
1.1.3 Skalare.
1.1.4 Gelykheid van vektore.
1.1.5 Vektore as geordende reële twee-talle en drie-talle. Komponente.

1.2 Bewerkings met vektore.

<u>Opmerking:</u> In hierdie afdeling en verder word nuwe begrippe algebraïes ingevoer in terme van die komponent=notasie. Die resultate word dienooreenkomstig geformu=leer en bewys. Meetkundige interpretasie van hierdie begrippe en resultate word sover moontlik gehandhaaf.

1.2.1 Komponentsgewyse optelling vir vektore.

1.2.1.1 Die assosiatiewe wet vir vektor-optelling.
1.2.1.2 Die kommutatiewe wet vir vektor-optelling.
1.2.1.3 Die nul-vektor.
1.2.1.4 Die inverse van 'n vektor.

1.2.2 Vermenigvuldiging van 'n vektor met 'n skalaar.

1.2.2.1 Die distributiewe wette.
1.2.2.2 Die assosiatiewe wet.
1.2.2.3 Die identiteitsreël.

1.3 Basis en dimensie.

1.3.1 Lineêre afhanklikheid en onafhanklikheid van vektore.
1.3.2 Basis en dimensie.
1.3.3 Basisstelling vir vektore in die vektorruimtes R_2 en R_3.

2. <u>Produkte</u>

2.1 Die skalaarproduk.

2.1.1 Definisie van die skalaarproduk van twee vektore.
2.1.2 Die hoek tussen twee vektore.
2.1.3 Eienskappe van die skalaarproduk.

2.2 Die vektorproduk.

2.2.1 Definisie van die vektorproduk van twee vektore.
2.2.2 Eienskappe van die vektorproduk.

3. <u>Toepassings</u>

3.1 Die vektor- en Cartesiese vergelykings van 'n reguit lyn in R_2 en R_3.
3.2 Die vektor- en Cartesiese vergelykings van 'n plat vlak in R_3.
3.3 Enkele toepassings met betrekking tot die senior sekon=dêre leerplan, o.a.

3.3.1 Saamlopige lyne in 'n driehoek (lineêre onafhank=likheid).
3.3.2 Die cosinusreël (skalaarproduk).
3.3.3 Die sinusreël (vektorproduk).

C. <u>ANALISE</u>

1. <u>Die funksiebegrip</u>

1.1 Relasies tussen twee versamelings X en Y.
1.2 'n Funksie as 'n spesiale tipe van relasie met besondere klem op die afbeeldingsgedagte.
1.3 Die gebied, voorskrif en terrein van 'n funksie $f : X \rightarrow Y$. Onafhanklike en afhanklike veranderlikes.
1.4 Beelde en inverse beelde. Die begrippe injeksie, surjeksie en bijeksie.

1.5 Inverse funksies en samegestelde funksies.

1.6 Reëelwaardige funksies van een reële veranderlike. Die algebra van sodanige funksies. Die grafieke en grafiese voorstelling van reëelwaardige funksies.

2. <u>Die sirkelfunksies</u>

2.1 Die radiaalmaat vir hoeke.

2.2 Hoeke (in standaardposisie) van willekeurige grootte $\alpha \in R$.

2.3 Definisies van die trigonometriese verhoudinge vir 'n willekeurige hoek $\alpha \in R$ in term van koördinate.

2.4 Die sirkelfunksies.

2.4.1 Die ses relasies $\sin = \{(x;\ \sin x)/x \in R\}$;

$\tan = \{(x;\ \tan x)\ /x \in R - \{\frac{\pi}{2} + n\pi\ /\ n \in Z\}\}$,

ens. as funksies.

Grafiese voorstelling. Die periodisiteit van die ses funksies.

2.4.2 Beperking van die gebiede van die sirkelfunksies ten einde hulle bijektief te maak. Die inverse sirkelfunksies. Grafiese voorstellinge.

2.5 Identiteite.

2.5.1 Die drie basiese identiteite wat op die stelling van Pythagoras berus.

2.5.2 Die waardes van $f(\alpha + 2n\pi)$, $n \in Z$; en $f(-\alpha)$ in terme van $f(\alpha)$, waar f die ses sirkelfunksies deurloop.

2.5.3 Die identiteit $\cos(\alpha - \beta) = \cos\alpha \cos\beta + \sin\alpha \sin\beta$.

Herleiding van die identiteite vir $\cos(\alpha+\beta)$, $\sin(\alpha \pm \beta)$, $\tan(\alpha \pm \beta)$.

2.5.4 Somme en verskille van gelyknamige verhoudinge (sinusse en cosinusse) as produkte van verhou= dinge en omgekeerd.

2.5.5 Identiteite vir dubbel- en halwe hoeke.

2.5.6 Die waardes van $\sin x$, $\cos x$, $\tan x$ in terme van $t = \tan \frac{x}{2}$.

2.6 <u>Trigonometriese vergelykings</u>

3. Verdere eienskappe van die reële liggaam

3.1 Orde-aksiomas vir die reële liggaam.
3.2 Die relasies „kleiner as"en „groter as" in R. Elementêre eienskappe van hierdie relasies.
3.3 Die modulusfunksie en sy basiese eienskappe.
3.4 Intervalle en δ -omgewings in R.

4. Die limietbegrip

4.1 Intuïtiewe aanloop.
4.2 Formele definisie van die limietbegrip. Direkte toepas= sing van die definisie op veeltermfunksies van die eerste graad.
4.3 Basiese resultate.

4.3.1 Die eenduidigheid van die limiet.
4.3.2 Stellings oor limiete betreffende die rasionale bewerkings met funksies.
4.3.3 Stellings oor limiete betreffende 'n gegewe funksie relatief tot 'n ander funksie of funksies.
(- - bewyse word slegs in die eenvoudigste gevalle verlang).

4.4 Besondere resultate.

4.4.1 $\lim_{x \to a} c = c$, c konstant.
4.4.2 $\lim_{x \to 0} \sin x = 0$; $\lim_{x \to 0} \cos x = 1$; $\lim_{x \to 0} \frac{\sin x}{x} = 1$.

4.5 Linker- en regterlimiete.

4.5.1 Definisie en geldigheid van die resultate 4.3 en 4.4.
4.5.2 $\lim_{x \to a} f(x) = L$ as en slegs as
$\lim_{x \to a} + f(x) = \lim_{x \to a} f(x) = L$.

4.6 Die limiete $\lim_{x \to \infty} f(x)$ en $\lim_{x \to -\infty} f(x)$.

5. Kontinuïteit

5.1 Definisie van kontinuïteit by 'n punt.
Kontinuïteit op 'n interval.
5.2 Die algebra van kontinue funksies.

5.3 Samehang in R.
5.4 Samehang as invariant onder kontinue afbeelding.
5.5 Worteltrekking in (R, +, X).

6. <u>Differensiasie</u>

6.1 Definisie en meetkundige vertolking van die afgeleide van 'n funksie by 'n punt.
6.2 Kontinuïteit as noodsaaklike voorwaarde vir differensieer= baarheid.
6.3 Die afgeleide van 'n konstante funksie en die magsfunksie $f = \{(x\ ;\ y)/y = x^n\}$. (Bewys slegs vir $n \in N$ verlang).
6.4 Differensiasie-reëls m.b.t. somme, verskille, produkte en kwosiënte van differensieerbare funksies.
6.5 Differensiasie van samegestelde funksies, implisiete funksies en inverse funksies.
6.6 Differensiasie van die sirkelfunksies en hulle inverse funksies.
6.7 Die stelling van Rolle (sonder bewys= en die middelwaarde= stelling.
6.8 Hoër afgeleides. Die stelling van Leibniz.
6.9 Stygende en dalende funksies. Relatiewe maksima en mini= ma.
6.10 Draaipunte en buigpunte. Die skets van krommes.

7. <u>Integrasie</u>

7.1 Definisie en elementêre eienskappe van die bepaalde inte= graal.
7.2 Definisie en elementêre eienskappe van die onbepaalde integraal.
7.3 Die grondstelling van die integraalrekene.
7.4 Integrasie-tegnieke.

 7.4.1 Standaardvorme.
 7.4.2 Die Substitusiebeginsel.
 7.4.3 Parsiële integrasie.

8. <u>Die logaritmiese en eksponensiaalfunksies</u>

8.1 Definisie en basiese eienskappe van hierdie funksies.
8.2 Toepassing van differensiasie en integrasie op hierdie funksies.
8.3 Logaritmiese differensiasie.

9. Toepassings

9.1 Eenvoudige toepassings van integrasie by die berekening van oppervlaktes en volumes van omwentelingsliggame."

"VIERDE JAAR
(10 periodes per week hele jaar)

(B. KURSUS)

1. Rente: (Eenmalige belegging)
Hersiening van grondbegrippe.
Enkelvoudige Rente.
Samegestelde rente. (Tabel I en II)
Nominale en Effektiewe rentekoers (Tabel VI).
Gelykwaardigheidsbeginsel.
Voorbeelde m.b.t. bostaande.

2. Jaargelde (Annuïteite). (Periodieke beleggings)
(60 periodes).
Soorte: vooruitbetaalbare en agternabetaalbare.
Termyn, periode.

(a) Rente-omsettingsperiode en periode van jaargeld gelyk
Bepaling van slotwaarde (Tabel III), kontantwaarde (Tabel IV), paaiement (Tabel V), termyn en rente=koers, beide vir agternabetaalbare en vooruitbe=taalbare jaargelde.

Verband tussen $\frac{1}{a_{\overline{n|}}}$ en $\frac{1}{s_{\overline{n|}}}$

Perpetuïteite.
Uitgestelde jaargelde.

(b) Rente betaalbaar m keer per jaar, paaiement van jaargeld jaarliks betaalbaar
Berekening van kontant- en eindwaardes vir agterna- en vooruitbetaalbare jaargelde.

(c) Rente betaalbaar jaarliks, paaiement van jaargeld p maal per jaar betaalbaar
Berekening van kontant- en eindwaardes vir vooruit- en agternabetaalbare jaargelde.

Gelykwaardigheidsbeginsel.

3. <u>Aflossing van lenings</u> (20 periodes)
Amortisasieskemas: opstel van tabel om jaarlikse paaie= ment opgesplit in rente- en kapitaalbestanddeel asook kapitaal uitstaande, aan te toon.
Skuld afgelos en skuld uitstaande op enige tydstip.
Delgingsfondse: Opstel van tabel om jaarlikse paaie= ment, renteverdienste en stand van delgingsfonds aan te toon. Betalende sowel as verdiende rentekoers.

4. <u>Kapitalisasie en afskrywing van bates</u> (20 periodes)
Gekapitaliseerde koste.
Oorskotwaarde.
Slytasiewaarde.
Waardevermindering en afskrywing.
  Reguitlyn metode.
  Konstante persentasie metode.
  Delgingsfonds metode.

5. <u>Prys en koersbepaling van aandele, effekte en obligasies</u> (20 periodes)
Grondbegrippe: Aandele, voorkeuraandele, obligasies of skuldbriewe, nominale waarde, afloswaarde, teen pari, diwidend, uitgifteprys, prys of markwaarde, rente-opbrengs.
Betaling van markwaarde gegewe afloswaarde, diwidend, termyn en rente-opbrengs asook rente-opbrengs as ander drie gegewe is.

6. <u>Grafiese voorstellings: reëlmatige krommes</u> (20 periodes)

Reguit lyn $y = a + bx$, en b konstantes.

Sirkel $x^2 + y^2 = a^2$, a konstant.

Eksponensiaalkromme $y = ae^{bx}$, a en b konstant.

Parabool $y = a + bx + cx^2$, a, b en c konstant.
Spesiale grafiekpapier: semilogaritmies asook dubbel logaritmies.

7. <u>Grafiese voorstellings, statistiese gegewens</u> (40 periodes)

Aard van statistiese gegewens.
Versameling van gegewens.
Klassifisering.
Tabulering.
Diagrammatiese voorstelling: Sirkeldiagramme, staaf= diagramme, beelddiagramme, kartogramme, tydkrommes, frekwensiekrommes.

Frekwensietabel.
Histogram.
Frekwensieveelhoek.
Kumulatiewe frekwensieveelhoek.

8. Sentrale Mate (30 periodes)

Vir beide gegroepeerde sowel as ongegroepeerde gegewens: rekenkundige gemiddelde, mediaan en modus.
Aflees van mediaan en kwartiele uit kumulatiewe frekwen=sieveelhoek.

9. Spreidingsmate (30 periodes)

Vir beide gegroepeerde sowel as ongegroepeerde gegewens: kwartiel afwyking, gemiddelde afwyking en standaard afwyking.
Variansie asook koëffisiënt van variasie.

10. Korrelasie en regressieanalise (30 periodes)

Verband tussen veranderlikes.
Reglyne regressie:
  Vergelyking van regressielyn.
  Gebruik van logaritmiese grafiekpapier.
Korrelasiekoëffisiënt vir ongegroepeerde gegewens.
Opstel van tweerigtingtabelle.
Berekening van korrelasiekoëffisiënt vir gegroepeerde data.
Rangkorrelasie van Spearman.

11. Elementêre toetse gebaseer op normaalkromme (30 periodes)

Die normaalverdeling aan die hand van tabelle.
Definisies en samestelling van waarskynlikhede.
Betekenis van 'n waargenome gemiddelde.
Betekenis van verskil tussen twee gemiddeldes."

The number of students taking the two optional specialization Mathematics courses are given in Table 3.2.

TABLE 3.2

THE NUMBER OF STUDENTS TAKING THE SPECIALIZATION MATHEMATICS COURSES AT THE TEACHERS' TRAINING COLLEGE, BLOEMFONTEIN, IN 1973 AND THE ESTIMATED NUMBERS FOR 1974

Course	1973		1974	
	Third year	Fourth year	Third year	Fourth year
Course A	0	0	40	0
Course B	24	5	32	5
TOTAL	24	5	72	5

During 1973 no primary school teachers took the A course mainly because the last course for the remaining secondary school teachers was still offered in its place. In effect this means that the A course is only being offered as from 1974 although primary school teaching students were offered the opportunity of doing the A course.

With regard to entrance qualifications for the A course, students are accepted for the course without having a matriculation exemp= tion pass in Mathematics. In other words, a School Leaving Certificate pass in Mathematics suffices. However, a student's achievement in the compulsory Arithmetic course during the first two years of study is also taken into account. As far as the B course is concerned, as many students as possible are encouraged to take this course subject to a reasonable mark for the com= pulsory Arithmetic course. No other entrance qualifications are required.

3.5.4 Method Courses for Mathematics

No separate Mathematics Method courses are offered for any of the above-mentioned Mathematics courses. The Compulsory Mathe= matics (Arithmetic) Course is an integrated Arithmetic Content and Method course and in practice the emphasis is actually on the methodology of the subject according to a college spokesman. The syllabus for the Compulsory Mathematics (Arithmetic) Course, however, makes no mention of method and it seems that this aspect is left solely to the judgement of the lecturers concerned.

As far as the two Optional Specialization Mathematics Courses are concerned, no provision is made for any Mathematics Method at all. The methodology of the Arithmetic course of the first and second years is considered sufficient. The two specialization courses are therefore solely for enriching the mathematical background of the students.

As far as teaching practice and the evaluation of a student's criticism lessons are concerned, the practice at the Teacher's Training College, Bloemfontein is that first and second year students doing the Compulsory Mathematics (Arithmetic) Course are examined by the college lecturer who is assigned to eva= luate all the students at specific schools. This means that the student giving a criticism lesson in Arithmetic is often examined by a lecturer whose subject is not Mathematics. However, it is organisationally impossible to arrange for all the students doing the Compulsory Mathematics (Arithmetic) Course to be examined by lecturers of the Mathematics Depart= ment, especially when the vast distances to be travelled, in this respect are taken into account.

The position is entirely different as regards the two Optional Specialization Mathematics Courses. The Mathematics Department in consultation with the lecturers of the Education Department succeed in arranging it in such a way that lecturers of the Mathematics Department examine the criticism lessons of the students specialising in Mathematics.

Forms are used by both the teachers and the visiting lecturers in judging the student's ability. These forms are general forms used for evaluating any criticism lesson regardless of the subject taught and are therefore not specifically mathe= matically orientated. Copies of the forms in use in the Orange Free State, Form B and Form C are given in the Appendix. Stu= dents are informed of their mark (a symbol) for a criticism lesson directly after the lesson when the visiting lecturer discusses the lesson with each student.

3.6 CONCLUSION

The position with regard to the training courses for primary school teachers at the provincial colleges of education is relatively healthy. This may always have been the case but it is particularly so now that the secondary teachers training has been moved to the universities. Accommodation at the col= leges is ample and the lecturers who previously specialised in subject content for the secondary school training courses are now mostly available to present the new content to the primary school student teachers. For this reason it is all the more unfortunate that so few young men enrol for the primary school teachers' training courses. Especially now that the Criteria (37) lays down that three-year training courses must raise the standard of their academic courses to first-year university level and the four-year course theirs to second-year university level, it is clear that experienced lecturers who had been doing exactly this for the secondary school student teachers made the transition from old to new syllabuses remarkably easily and successfully. New syllabuses and the schemes of work based on them were available without any delay and the new training courses got under way without any major disruptions. It is unfortunate, however, that the various specialist Mathe= matics courses offered by the colleges are not recognised by the universities for degree purposes, if only in part. Keeping this painless transition in mind the question arises whether the inclusion of large numbers of secondary student teachers at the universities resulted in an equally smooth transition.

Possibly the greatest shortcoming as regards the compulsory Mathematics courses offered at the colleges of education is the lack of any admission requirements in Mathematics (see par. 2.3). This means that the classes are heterogeneous with respect to mathematical qualifications resulting in frustration on the part of both lecturers and students alike. This is a problem which has already been raised in the previous chapter and for which a solution is offered in Paragraph 6.2.3. The position with regard to the training courses of secondary school teachers will be examined in the next chapter.

CHAPTER 4

THE TRAINING OF MATHEMATICS TEACHERS FOR THE SECONDARY SCHOOL IN THE REPUBLIC OF SOUTH AFRICA: THE STATUS QUO

4.1 INTRODUCTION

According to the National Education Policy Amendment Act (Act No. 73 of 1969) the training of White persons as teachers for the secondary school is to be solely the function of the universities as from 1 January 1976. No new students are at present being admitted to the provincial colleges of education for secondary teacher training and existing courses are in the process of being phased out. The new Education Act (Act No. 73 of 1969) is primarily aimed at reorganising the training of secondary school teachers so that it is in this field that the greatest change is being undertaken. One of the greatest problems that has arisen, apart from accommodation possibly, is that of training students who do not have full matriculation exemption to be teachers. These students had previously been admitted to the provincial colleges of education and had qualified for a provincial secondary school Teacher's diploma. The universities, however, have always insisted on full matriculation exemption as the minimum requirement for entry into any of their faculties. Especially now that the new Education Act has aimed at raising the standard of secondary teacher training by stipulating that the duration of the training had not to be less than four years and that a minimum of 8 degree courses had to be passed (37, Paragraph 11.4.10), the admittance of non-matriculation exemption students has raised a problem situation.

The solution to the above-mentioned problem lies in the following possibilities. The first is to admit the non-matriculation exemption students and provide courses for them at a less strenuous tempo as the usual degree courses but which would nevertheless bring them up to second-year degree standard by the end of their fourth year. In principle this is a good arrangement, provided that the courses which have been lengthened are also recognised for degree purposes so that the students taking them can later obtain a degree by acquiring the courses they are still short of for degree purposes extramurally. The university which has adopted this solution however, does not recognise the courses taken over a longer period for degree purposes, mainly because the content is completely different from that of the degree courses since they have been devised specifically for the needs of the secondary school teacher.

The second solution to the problem is simply to admit the non-matriculation exemption students and let them attempt the degree courses as provided by the university. Naturally the failure rate is very high especially in Mathematics and the other science courses, which could result in the shortage of Mathematics and Science teachers being further aggravated. A solution similar to this one, but with the advantage of avoiding the stigma of a high failure rate, is simply not to admit any non-matriculation exemption students. At least one university has adopted this solution, which also has the effect of aggravating the shortage of qualified teachers, especially in Mathematics and Science. This university maintains however, that the answer to the teacher shortage question does not lie in the lowering of standards and admission requirements.

Before the passing of the Education Policy Amendment Act (Act No. 73 of 1969) all the universities in South Africa were, to a lesser of greater extent, active in the training of secondary school teachers. The following table shows the universities and the number of secondary school courses which they offered in 1969. It is of interest to note that universities had not insisted on a full matriculation exemption as an admission requirement for some of their courses.

All the universities mentioned in Table 4.2 demand Mathematics II as minimum admission requirement for their Method of Mathematics Courses. The Potchefstroom University for CHE naturally demands its Secondary Mathematics II Course which was spesifically devised for the four-year non-degree teachers training course as minimum admission requirement for the Subject Didactics (Mathematics) Course. All the above universities, however, have realised that, with the shortage of Mathematics teachers being as acute as it is, students with Mathematics I to their credit simply cannot be overlooked. For this reason students with Mathematics I to their credit are also being encouraged to follow the Subject Didactics Course in Mathematics (see Paragraph 4.2.1 c., and Table 4.4).

It will immediately be noticed that the universities have extended their teacher training courses considerably and that, with two exceptions, they all offer a four-year non-degree teacher training course for aspirant secondary school teachers who do not have a matriculation exemption certificate. The University of the Witwatersrand, the University of Natal and the University of Cape Town, differ from this policy because of the fact that they insist on a matriculation exemption certificate even for their non-degree diplomas.

TABLE 4.1

SUMMARY OF THE MAIN INITIAL PROFESSIONAL TRAINING COURSES FOR SECONDARY TEACHERS AT SOUTH AFRICAN UNIVERSITIES FOR WHITE PERSONS, 1969

(Specialised Courses in music have been omitted)

University	Course	Duration	Admission Requirements	
			For Diploma Course	For Mathematics Specialisation Course
1. Cape Town	Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
2. Natal	University Education Diploma	1 year	Bachelor's Degree	Mathematics II
	University Education Diploma (Non-graduate)	1 year	Sufficient courses that will enable candidate to obtain the degree by one further year of study	Mathematics II
3. Orange Free State	University Education Diploma	1 year	Bachelor's Degree	Mathematics II
	Education Diploma in Physical Education	3 years	Senior Certificate	None
	Education Diploma in Commerce	3 years	Senior Certificate	Matriculation Exemption
	Education Diploma in Drama	3 years	Senior Certificate	N.A.
4. Potchefstroom	University Education Diploma	1 year	Bachelor's Degree	Mathematics II
	University Education Diploma (Guidance)	1 year	Bachelor's Degree + Psychology as major	N.A.
5. Pretoria	Higher Education Diploma	{1 year full time {1½ years part time	Bachelor's Degree	Mathematics II
	Higher Education Diploma (B.Com.)	1 year	B.Com plus a qualification in Shorthand and Typewriting	Mathematics II

University	Course	Duration	Admission Requirements	
			For Diploma Course	For Mathematics Specialisation Course
	Diploma in Physical Education	3 years	Senior Certificate	N.A.
6. Rhodes	University Education Diploma	1 year	B.A., B.Sc., or B.Com.	Mathematics II
	University Education Diploma (Non-graduate)	4 years	Completed two years of study towards Bachelor's Degree	Mathematics II
	Lower Secondary Teachers' Diploma	3 years	Matriculation	Matriculation Exemption pass in Mathematics
	Art Teachers' Certificate	4 years	Matriculation	N.A.
	Lower Secondary Teachers' Diploma	3 years	Senior Certificate	School-leaving Certificate pass in Mathematics
	University Art Teachers' Diploma	4 years	Matriculation	N.A.
	University Art Teachers' Diploma	4 years	Matriculation	N.A.
7. South Africa	University Education Diploma	1 year	Bachelor's Degree and two years of teaching experience	Mathematics II
8. Stellenbosch	Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
	Lower Secondary Teachers' Diploma	3 years	Senior Certificate	Matriculation Exemption pass in Mathematics
	Teachers' Diploma in Art Education	1 year	Diploma in Art	N.A.
	Teachers' Diploma in Domestic Science and Needlework	1 year	Diploma in Domestic Science	N.A.
	Teachers' Diploma in Physical Education	3 years	Senior Certificate	N.A.

University	Course	Duration	Admission Requirements	
			For Diploma Course	For Mathe= matics Spe= cialisation Course
9. Port Eliza= beth	Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
	Lower Secondary Teachers' Diploma	3 years	Senior Certificate	Matriculation Exemption pass in Mathematics
10. Witwaters= rand	University Edu= cation Diploma	1 year	Bachelor's Degree	Mathematics II

(3, p. 281)

Table 4.2, which follows, gives an idea of the secondary school training courses offered by the various universities during 1973.

TABLE 4.2

THE MAIN PROFESSIONAL TRAINING COURSES FOR SECONDARY TEACHERS AT SOUTH AFRICAN UNIVERSI= TIES FOR WHITE PERSONS, 1973*

University	Course	Duration	Admission Requirements	
			For Diploma Course	For Mathe= matics Spe= cialisation Course
1. Cape Town	Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
2. Natal	The University Edu= cation Diploma (Graduate)	1 year	Bachelor's Degree	Mathematics II
	The University Edu= cation Diploma (Non-graduate)	4 years	Matriculation Exemption	Mathematics II
3. Orange Free State	University Education Diploma	1 year or 18m. part-time	Bachelor's Degree	Mathematics II
	University Education Diploma (Non-graduate) with the following en= dorsements: General, Natural Sciences, Phy= sical Education, In= dustrial Arts, Domestic Science, Art, Commercial Subjects and Drama	4 years	Senior Certificate with English and Afrikaans	Senior Certificate pass in Mathematics

University	Course	Duration	Admission Requirements	
			For Diploma Course	For Mathematics Specialization Course
4. Potchefstroom U. for CHO	University Education Diploma	1 year	Bachelor's Degree	Mathematics II
	Higher National Secondary Diploma	4 years	Secondary School-Leaving Certificate with Afrikaans and English	Secondary School-Leaving Certificate pass in Mathematics
5. Pretoria	Higher National Education Diploma	1 year	Bachelor's Degree	Mathematics II
	Higher National Education Diploma with the following endorsements: General, Special Education, Industrial Arts, Commerce, Domestic Science, Commerce (Secretarial), Art, Agriculture, Physical Education, Music, Technical and Industrial Arts	4 years	Secondary School-Leaving Certificate with Afrikaans and English	Mathematics II for Std. 10 Method Mathematics I for Std. 8 Method
6. Rhodes	National Higher Education Diploma	1 year	Bachelor's Degree	Mathematics II
	National Higher Education Diploma (Non-graduate)	4 years	Secondary School-Leaving Certificate	Mathematics II
7. South Africa	University Education Diploma	1 year	Bachelor's Degree and two years of teaching experience	Mathematics II
8. Stellenbosch	The Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
	Four-year Secondary Teachers' Diploma	4 years	Sec. School-Leaving Certificate. But Matric. Exemption Pass in Mathematics is demanded by the Fac. of Science	Mathematics II
9. Port Elizabeth	Baccalaureus Scientiae (Secondary Teaching)	4 years	Matriculation Exemption	Mathematics II
	Baccalaureus Artium (Secondary Teaching)	4 years	Matriculation Exemption	Mathematics II
	Higher National Education Diploma	1 year	Bachelor's Degree	Mathematics II
	Higher National Education Diploma (Non-graduate) with the endorsements Human Sciences, Natural Sciences and Economic Science	4 years	Senior Certificate	Mathematics II

University	Course	Duration	Admission Requirements: For Diploma Course	Admission Requirements: For Mathe= matics Spe= cialisation Course
10. RAU	Bachelor of Arts (Education) BA (Ed.)	4 years	Matriculation Ex= emption	Mathematics II
	Bachelor of Commerce (Education) B.Com. (Ed.)	4 years	Matriculation Ex= emption	Mathematics II
	Bachelor of Science (Education) B.Sc. (Ed.)	4 years	Matriculation Exemption	Mathematics II
	Post-graduate Secondary Teachers' Diploma	1 year	Bachelor's Degree	Mathematics II
	Secondary Teachers' Diploma with the following endorsements: Languages and Human Sciences, Commerce (Practical Subjects), Physical Education and Industrial Arts	4 years	Senior Certificate with Afrikaans and English and aggre= gate of at least 50 %	50 % pass in Senior Certificate Mathematics
11. Wit= waters= rand	Higher Diploma in . Education	1 year	Bachelor's Degree	Mathematics II
	Diploma in Education	4 years	Matriculation Exemption but Senior Certificate may be accepted until 1976	Matriculation Exemption Pass in Mathematics
	Diploma in Remedial Education	2 years part-time	B.-degree with diploma and 2 years experience or Diploma with 5 years experience	N.A.

* (Specialised courses in music have been omitted)

Before looking at the various courses that the universities are offering, it would be of value to examine the requirements for such courses as laid down in the November 1972 Revised Edition of the Criteria for the Evaluation of South African Qualifi= cations for Purposes of Employment in Education (37). The above-mentioned Criteria make provision for three different types of teacher training courses, namely a four-year non-degree course, a Bachelor's degree and post-graduate four-year combination, as well as a four-year Bachelor's degree in Edu= cation for the Secondary School.

The first-mentioned secondary teacher's training course is a diploma course which has as minimum academic requirements the following: At least eight courses which are comparable with degree courses and at least one of which (a school subject) must be comparable with a third-year degree course and at least one (also a school subject) comparable with a second-year degree course or at least two subjects (school subjects) comparable with a second-year degree course and another school subject comparable with.a first-year degree course (37, Paragraph 11.4.10.2). Needless to say, Mathematics is considered to be a school subject. As far as the professional requirements for the school subjects are concerned, the Criteria stipulates that the method of at least two subjects up to Std 10 level must be included or the method of one subject up to Std 10 level and one subject up to Std 8 level. These minimum requirements for the four-year training course for the Secondary School also apply to the remaining two training courses already named. This means for instance, that a person who does a Bachelor's degree and then decides to take up teaching as a career, will only be accepted provided that his degree satisfies the above minimum requirements. However, in practice it is unlikely that a person with a Bachelor's degree will be turned down if his degree does not completely satisfy the requirements.

Table 4.3 shows which of the three training courses each university in South Africa offers.

From Table 4.3 it is clear that only two universities have decided to offer the four-year Bachelor's degree in Education. The reason for this is not clear at this stage, but it probably has something to do with the universities being in the throes of reorganising their teachers' training courses and are there= fore not wanting to introduce too many innovations too soon. Both the Rand Afrikaans University and the University of Port Elizabeth are universities that have very recently come into being (late in the nineteen sixties) so that the introduction of new courses would presumably **be** easier for them. In the

TABLE 4.3

TABLE SHOWING WHICH OF THE THREE INITIAL TRAINING COURSES FOR SECONDARY SCHOOLS ARE PROVIDED BY EACH UNIVERSITY

University	4-year Training Course for Secondary Schools	One-year Post-graduate Course for Secondary Schools	4-year Bachelor's Degree in Education
Cape Town	×	×	
Natal	×	×	
Orange Free State	×	×	
Potchefstroom	×	×	
Pretoria	×	×	
Rand Afrikaans	×	×	×
Rhodes	×	×	
South Africa		×	
Stellenbosch	×	×	
Port Elizabeth	×	×	×
Witwatersrand	×	×	

following paragraphs the position with regard to the various training courses available to prospective secondary school teachers at each university will be discussed.

4.2 MATHEMATICS COURSES FOR THE SECONDARY SCHOOL TEACHER'S DIPLOMAS

The universities have been given a comparatively free hand in their choice of syllabuses for the training of secondary school teachers and their autonomy is in no way touched. There are two possible courses which the universities may adopt for the training of Mathematics Teachers. They can either offer the ordinary first, second and third-year degree courses in Mathematics for those prospective secondary school teachers who wish to specialise in Mathematics, or they can compile school-orientated Mathematics courses comparable to degree standards. To date all the universities with the exception of the Potchefstroom University for Christian Higher Education expect their teaching students to take the ordinary degree courses in Mathematics as provided for all their students, irres= pective of the profession they are aspiring to. The University of the Witwatersrand has compiled a third-year Mathematics course catering specifically for the needs of prospective teachers. The various Mathematics courses at each of the universities will be discussed.

4.2.1 The University of Cape Town

a. Introduction

At present the University of Cape Town offers only one second= ary teacher's training course and that is the Secondary Teacher's Diploma (STD), a one-year post-graduate diploma. Candidates for this Diploma must be graduates offering not fewer than two subjects taught in the schools. In one of these they must have successfully completed three courses and in the other two courses.

The curriculum of the above diploma in broad outline is as follows (45, p. 21):

1. Theory of Education.
2. History of Education.
3. Methodology of Education.
4. Psychology of Education.
5. Secondary School Subject Methods (at least two subjects taught in the schools, e.g. Mathematics).
6. Teaching Auxiliaries.
7. Educational Enrichment Units.
8. Language Skills.
9. Teaching practice.

b. Optional Mathematics Courses

The syllabuses of the optional Mathematics courses, which students enrolled for the STD may have taken during the under= graduate years if they intended specialising in Mathematics, are as follows (45, p. 150):

"MATHEMATICS Ia

Inequalities and absolute values. Co-ordinates in the plane. Graphs. Functions. Straight lines and circles. Radian measure.

Circular functions. Limits of sequences and functions. Differential Calculus. Maxima and minima. Partial differentiation. Integral Calculus. Areas and volumes. Properties of polynomials. Binomial theorem. Systems of linear equations. Matrices.

MATHEMATICS Ib

Determinants. Vectors and three-dimensional geometry. Complex numbers. Differential equations of first and second order. Sequences and series. Improper integrals and applications of integration. Conic sections.

References

S. Lang: A First Course in Calculus (2nd ed.).
M.R. Spiegel: Mathematical Handbook.
W. Ledermann: Complex Numbers.
J.A. Green: Sequences and Series.

MATHEMATICS IIa

Syllabus

Elements of Analysis:

The axiom of continuity. Heine-Borel. The nested interval property of the reals. Bolzano-Weierstrass. The Cauchy property of the reals. Sequences. Continuity, uniform continuity. Differentiability. Taylor's theorem. L'Hospital's rules. The Riemann integral. Partial differentiation and applications. Vector valued functions. Extreme values. Multiple and line integration. Green's theorem. Stokes' theorem. Improper integrals. Gamma and Beta functions. Infinite series. Fourier series and Fourier integrals. Differential equations.

Geometry and Linear Algebra

Solid analytic geometry. Quadric surfaces. Linear equations. Matrices. Gauss reduction. Vector spaces and subspaces. Basis and dimension. Determinants. Eigenvalues and eigenvectors. Elementary functions of a complex variable. Conformal maps.

References

M.H. Protter and C.B. Morrey: Modern Mathematical Analysis.
M.R. Spiegel: Advanced Calculus.
S. Lipschutz: Linear Algebra

Examinations

Two 3-hour papers in October/November."

No specialised course to suit the needs of prospective Mathe= matics teachers is available or is being envisaged for the near future.

c. Mathematics Method Courses

Students who have successfully completed at least Mathematics II are allowed to attend the Method of Mathematics Course during their fourth year of post-graduate diploma study. However, stu= dents who have only completed Mathematics I are permitted to attend this course during their fourth year of post-graduate professional training. If they successfully complete the Method of Mathematics Course, they are credited on their diplomas with the school subject method for Mathematics (Minor). At present (1974) there are 19 students enrolled for the Method of Mathematics Course, 10 of whom are Mathematics (Minor) candidates. The syllabus for the Method of Mathematics Course is as follows:

"UNIVERSITY OF CAPE TOWN: METHOD OF MATHEMATICS COURSE

A discussion on the nature of mathematics. (e.g. Is it a body of knowledge or a set of skills? Is it essentially rigorous or essentially intuitive? Which of these facets should be stressed in teaching different parts of school mathematics?)

The various principles of teaching mathematics, such as starting with a situation that is familiar, creating situations that require new concepts before introducing the concepts, establishing concepts by use rather than by exposition, the need for drill and the misuse of drill, how to teach for transfer of training etc. are not treated as such - they are brought out in going through those parts of the syllabus from Standard 6 to Standard 10 where beginning teachers need most help, such as directed numbers, the beginning of algebra and geometry etc.

Instruction is given in setting and marking exams.

Books

The students use two school textbooks: Senior Certificate Mathematics and standard 8 Mathematics, (with a guide for teachers) both by C. de Jager.

The following books are some of those recommended for them to consult:

Polya: How to solve it
Butler and Wren: The teaching of Secondary Mathematics
National Society for the Study of Education: Mathematics Education
Eves and Newsom: An Introduction to the Foundations and Fundamental Concepts of Mathematics
Sawyer: Vision in Elementary Mathematics
E.T. Bell: Men of Mathematics."

It was also possible to obtain copies of past Method of Mathematics examination papers from the University of Cape Town of which the following are examples:

"August 1973 U C T   Method of Mathematics   2 hours   100 marks

1. In teaching mathematics we can drill our pupils in manipulative skills and techniques or teach for insight and understanding. State your own attitude about this. Illustrate the points you make by giving specific cases and examples. (The value of your answer will depend on how well your examples illustrate your points.) (30)

2. Pupils taking mathematics must not only learn deductive thinking, but also inductive thinking and guessing. Show briefly, with specific examples, how you would let your pupils get experience in this skill. (20)

3. a) What are the most important points you would make when teaching the solution of inequalities? (10)

   b) Solve the inequality: $\frac{1}{x-2} \geqslant \frac{1}{3}$ (10)

4. If $y = \frac{2x-7}{x-3}$ a) What value can x not have? (1)
   b) What value can y not have? (3)

5. If $T_1 = 1$ and $T_{n+1} = 2T_n + 1$, write down T_2, T_3 and T_n (4)

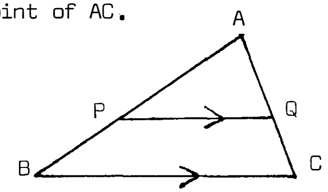
6. Solve for real values of x: $x - 1 = \sqrt{\frac{13}{16} - x}$ (6)

7. Prove that if you add 1 to the sum of the squares of 3 consecutive odd numbers, the answer is divisible by 12. (6)

8. a) Explain (at school level) why, if an assumption leads

to the truth it proves nothing, whereas, if an assump=tion leads to a contradiction or falsehood, it proves that the assumption is false. (You may use illustrations to bolster up your reasoning.) (5)

b) The line joining the midpoints of two sides of a triangle is parallel to the third side. Use this theorem to prove by reductio ad absurdum that if P is the midpoint of AB in $\triangle$ ABC, and PQ // BC, with Q on AC, then Q is the midpoint of AC. (5)



"September 1972 UCT Method of Mathematics 2 Hours

1. a) What is the converse of a statement? (2)

   b) Give an example of a statement that is true and whose converse is also true. Give the converse. (2)

   c) Give an example of a statement that is true and whose converse is not true. Give the converse. (2)

2. There are various faults that a question in mathematics can have. Name at least three and illustrate your answer by setting in each case a question that has the fault you name. Then show clearly why you think the question has that fault. In at least one case show how the question can be changed so as to eliminate the fault. (The value of your answer will depend on the effectiveness of your examples for your purpose.) (15)

3. a) Set a question in trigonometry to test direct knowledge.

   b) Set a question in trigonometry to test direct applica=tion of knowledge.

   c) Set a question in mathematics to test indirect appli=cation of knowledge.

   d) Set a question in mathematics to test insight. (9)

4. "We must teach mathematics so that it will be useful."

Show how you will do this. (You can deal with one or several topics or even write in general. The specific examples you use to illustrate your answer will count a lot. Your answer should be about 2 pages.) (25)

5. Give an example of something in elementary mathematics that you have found interesting or beautiful. (If you are desperate you can use something you have heard from me, but the value of your answer will be greatly increased if you come up with something I have never heard of.) In about 1 to 2 pages show how you would communicate this to a class so that they will also find it interesting. (You need not go into all the details - I can manage on hints. But show clearly how you would introduce the subject. After that an outline of your treatment will do.) (25)"

A feature of the Method of Mathematics course as offered at the University of Cape Town is the emphasis which is placed on encouraging the students to read articles and books on the subject of Mathematics Method as background. An excellent list of recommended books, complete with a line or two of comment on the contents of each and whether they are suitable for pupils or teachers, is given to students taking the Method of Mathematics Course. This list is considered of such value that it is being included here:

"<u>M A T H E M A T I C S: Recommended books</u>

Key: * - Specially recommended
PR - For pupils to read
PW - For pupils to work from on their own
T - For teachers

* PR 1. Adler: Learning with Colour: MATHEMATICS, exploring world of numbers and space. (London. Hamlyn 1966.)
An excellent book, beautifully illustrated. Suitable for pupils from Std 6 on.

* T PW 2. Allendoerfer and Oakley: Principles of Mathematics. 2nd Ed. (International Students Edition R4.05)
This is the first-year text-book of UCT. An excellent general book for teachers and a good book for exceptional pupils to use to start preparing for the university.

* PR 3. Bell, E.T.: Men of Mathematics (Penquin, 2 vols.)

This is a Brilliant and inspiring book. Every teacher of mathematics and every bright pupil should read it.

* PR 4. Bergamini: Mathematics (Nederland. Time-Life Inter= national 1965. Life Science Libary)
An excellent book, beautifully illustrated. Slightly more advanced than 1. Suitable for Std. 8 and upwards.

T 5. Boon, F.C.: A Companion to School Mathematics. (Longmans 1960)
This book was first published in 1924 but is still very valuable to the teacher who takes his subject seriously. It takes a deeper look at many important aspects of elementary mathematics and there is a lot to learn from it that will help you in presenting your subject.

T 6. Courant and Robins: What is Mathematics. (Oxford University Press)
This is an outstanding book about many important aspects of mathematics, but you must know your mathematics well, or be prepared to work if you want to read it. Very strongly recommended to any teacher who really wants to have a thorough overall idea of the subject.

*** T 7 Eves and Newsom: An Introduction to the Foundations and Fundamental Concepts of Mathematics. (Holt, Rhinehart and Winston 1965 About R8).
This is the best book you can read to get an idea of the development of modern mathematics. It is a university textbook written from the historical point of view. This should be compulsory reading for every teacher.

T 8 Fehr, H.F.: Secondary Mathematics: A functional approach for teachers. (Boston Heath 1951).
This book contains valuable material for teachers who are prepared to work at their subject.

* T 9 Organisation for Economic Co-operation and Development: Mathematics To-day, a guide for teachers (New Thinking in School Science).
This is the report of an international working session on new teaching methods for school mathematics, held in Athens in 1963, and attended by leaders in the field from all over the world. This is essential

reading for everyone who has to make decisions about where we are going in school mathematics. (All publications by the OECD are worthwhile.)

PR 10. Hogben: Mathematics in the Making (London, Macdonald 1960). This was the prize awarded to all those who qualified for the second round of the mathe= matics olympiad, 1966. They thought it excellent.

PR 11. Kasner and Newman: Mathematics and the Imagination (London, Bell, 1950)
Interesting general reading with good problems.

T 12. Land F.W. (Editor) New approaches to Mathematics Teaching. There are few books on methods of teaching the new maths. This is a good one and includes a fair amount about the psychology of teaching mathe= matics. Valuable for anyone who thinks seriously about teaching.

* T 13. Newman, J.R.: The world of Mathematics (Allen and Unwin 4 volumes)
This is a brilliant collection of mathematical writings of many kinds. This is the first thing to buy when you start a mathematical section of a library.

* T 14. Rosenthal, E.B.: Understanding the New Mathematics. (Crest books; about 60 cents)
An excellent book, well written and full of material that will be useful in actual teaching.

PR 15. Steinhaus, H. Mathematical Snapshots (Oxford Univ. Press) A beautiful book, full of really interesting and original material.

* T 16. PR Dantzig, T.: Number, the Language of Science. (4th Revised and augmented Edition. New York, MacMillan)
This is a classic, and should be read by every teacher.

* T 17. Bailey, C.A.R.: Sets and Logic 1. (London, Arnold 1964, Contemporary School Mathematics, First Series) An excellent book on sets. Suitable for use in class in Std 6 and 7. (About 60 cents)

* T 18 PW Kearney, A.P.: An Introduction to Sets (Blackie) R 1,20
Serves the same purpose as No. 17. Probably better.

* T 19. PR — * Ogilvy, C. Stanley: Through the Mathescope. (Oxford) A brilliant and delightful book for general interest, containing some valuable mathematics.

** T 20. PR — Northropp, Eugene P.: Riddles in Mathematics. (Pen= guin) A brilliant book. The best book on mathematical puzzles and paradoxes at school level ever written.

* T 21. PR — Gamow and Stern: Puzzle-Math. A small book with only about 12 puzzles, all excellent and well-discussed.

* PW22. — McArthur and Keith: Intermediate Algebra (Methuen) 80 cents. An ideal book for a bright pupil in Std 10 to work from on his own. The work is about first-year university standard, with excellent examples.

** PW23. — E.A. Maxwell: Advanced Algebra, Part 1 (Cambridge, R2.05) Similar to 22, but better written.

** PW24. — Tuckey and Armistead: Algebra (Longmans) Similar to 22 and 23, but still better. Ideal preparation for the university.

*** T 25. PW — Allendoerfer and Oakley: Fundamentals of Freshman Mathematics (McGraw-Hill) If you have to give a boy one book to prepare him for modern university mathematics, this is the book to choose. It is not as "modern" as No. 22, but is better to work from.

RECOMMENDED BOOKS ON MATHEMATICS

<u>General books that can confidently be recommended for a school library</u>

** 1. — The World of Mathematics - James R. Newman. (Allen and Unwin) (4 volumes) A wonderful collection of writings of all kinds on mathematics, with excellent comments by James Newman. This is the first thing to buy for the mathematics library.
The following articles in it should be read by every teacher: Mathematical Creation - Henri Poincaré
A Mathematician's Apology - G.H. Hardy
The Mathematician - John von Neumann

* * 2. Men of Mathematics - E.T. Bell (Penguin)
Excellent and inspiring accounts of the great mathematicians.

* * 3. Number, the language of science - Tobias Dantzig (Allen and Unwin)

* * 4. Riddles in Mathematics - Eugene P. Northrop (Penguin)
The best book on mathematical puzzles and paradoxes. Of real mathematical value.

* * 5. Puzzle-Math - Gamow and Stern
A little book with a few problems, but all of them are really good. Delightfully written.

*6. Mathematical Models - Cundy and Rollett (Oxford)
The teacher will find many valuable ideas in this book.

* * 7. Through the Mathescope - Stanley C. Ogilvey (Oxford)
Extremely well written and original.

* 8. From Zero to Infinity - Constance Reid (Routledge and Kegan Paul)
Suitable for Std 7 and 8.

<u>Books and Articles for Teachers to read</u>

* * 1. Craftsmanship in the teaching of elementary mathematics - F.W. Westaway (Blackie)
A really excellent book, giving general ideas and also detailed lessons. An ideal book for someone starting to teach to use.

* * 2. The Teaching of Secondary Mathematics - Butler and Wren (McGraw-Hill)
Has excellent bibliographies. Very good and a perfect complement to Westaway. An ambitious book that will be useful to anyone working for B.Ed.

* * 3. Reports issued by the Mathematical Association (Bell)
a) The teaching of Algebra in schools
b) The teaching of Geometry in schools
c) Second report on the teaching of Geometry in schools (This 2nd report is more useful)
d) The teaching of trigonometry in schools (Useful for the new syllabus)

* 4. The introduction to "What is Mathematics" by Courant and Robbins (Oxford)
(The book itself is excellent, but not suitable as escapist reading)

** 5. The following article in "Contemporary British Philosophy" 3rd Series:
Three Views of Truth – Karl Popper
This is a brilliant essay, actually on the philosophy of science, but essential reading for any mathematics teacher.

* 6. The following articles in "Mysticism and Logic" – Bertrand Russell (Penguin)
The Study of Mathematics
Mathematics and the Metaphisicians.

7. New Approaches to Mathematics Teaching – Edited by F.W. Land (MacMillan)
Reflects modern movements in England. Written by leaders in the field of teaching."

The Method of Mathematics Course is presented by lecturers of the Faculty of Education and not by lecturers of the Mathematics Department. This system is to be recommended as will be ex= plained later in this chapter (see paragraph 6.1.2(b)).

Teaching practice is also given a considerably important place in the professional training of prospective teachers. Apart from one school term's continuous teaching practice during the fourth and final year of study, two days a week is further spent on teaching practice during the year, one day for English and one day for Afrikaans medium teaching practice. Mini-teaching was introduced at the beginning of 1972. The Mathematics teachers in the schools concerned assist with the evaluation of a student's work during the one school term of continuous practice teaching but not with the evaluation of the weekly practice lessons. A form is completed by the principal of the school where a student does his continuous teaching practice. The principal acts on the advice given by all the teachers who observed the student. At College a separate mark is compiled from the headmaster's re= port and those of the lecturers for Method of Mathematics and for Teaching Ability which is considered a subject in its own right.

A candidate must pass each and every subject in the curriculum of the Methods Course before the diploma is issued. A candidate who passes all his other subjects but fails teaching practice, is given the opportunity to teach as an uncertified teacher. He can then apply to be evaluated again after six months or a year as determined by the Board of the Faculty of Education. The form used for evaluating the students' criticism lessons may be found in the Appendix (Form D).

4.2.2 The University of Natal

a. Introduction

The following diplomas are offered in the Faculty of Education to prospective secondary school teachers interested in specializing in Mathematics (46, p. 316): the University Edu= cation Diploma (Graduate) (UED) and the University Education Diploma (Non-graduate). The University Education Diploma (Graduate) is also reffered to as the University Education Diploma (Post-Graduate) and one year of post-graduate study is specified as minimum requirement for this Diploma.

b. Optional Mathematics Courses

(i) The University Education Diploma (Graduate)

Only graduates are eligible as candidates for the above diploma, provided that at least five "school" courses are included in the degree. The "school" courses must be spread so that either three of them are in one subject and two in another or two of them are in each of two school subjects and one in one school subject. Students who wish to take the Mathematics Method Course during their fourth, post-graduate year of study must have passed at least Mathematics II. No differentiation occurs with respect to prospective teachers taking Mathematics for degree purposes nor are there any "school-orientated" Mathematics courses designed specifically for the needs of teachers.

(ii) The University Education Diploma (Non-graduate)

The above diploma should not be confused with the four-year non-degree diplomas which have been instituted at many of the South African universities since 1972. The University of Natal, however, does not specifically offer such a four-year non-degree diploma as yet. Study for the UED (Non-graduate) may be commenced when progress in a degree course is such, that one further year of successful study would complete it. This implies that only students with a matriculation exemption pass at school can enrol for the above teaching diploma. The course lasts one academic year. Often students are only one minor subject short for their degree. Many pass it in the UED year and therefore emerge with the graduate UED. Numbers in this category will now decline in view of the Criteria requirements.

The University of Natal does however intend, in collaboration with the Natal Education Department, to offer four-year non-degree teacher training courses satisfying the requirements of the Cri= teria, but at present there is no intention of providing a school-orientated Mathematics course for students enrolled for this diploma.

c. Mathematics Method Courses

The syllabus of the Mathematics Method Course at the University of Natal is as follows:

"UNIVERSITY OF NATAL

MATHEMATICS METHOD: UED

DEPARTMENT OF EDUCATION: PIETERMARITZBURG CENTRE

The Mathematics Method examination for UED is divided into two parts: one related to teaching techniques, the other to history.

1. TEACHING TECHNIQUES (METHOD)

This part of the course is formally examined at the end of the year when a two-hour paper is written. It is set by the lecturer and moderated by the Head of the Department of Edu= cation. The paper counts for 50 marks.

Syllabus:

1. Symmetry - Geometric: Stds. VI to VIII
   - Geometric and Algebraic: Stds. IX to X.

2. Geometrical Constructions in Std. VI.

3. Introduction of Locus to a Std. VIII class.

4. Difficulties in Rider Work: Suggestions enabling pupil to have greater success. Techniques of blackboard work.

5. Properties of the Number System.

6. Methods of Teaching the Straight Line graph. $\left\{(x,y): y=mx+c\right\}$

7. Methods of Teaching Factorisation.

8. Solution of Trigonometric Problems using Formulae.
2-D and 3-D drawings. Also: Marking and mark schemes: discussion of dangers in the use of "rules".

9. Methods of Teaching Concurrency in Geometry.

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2. HISTORY OF MATHEMATICS

An essay (or junior theses) on a topic in the field of mathe= matics. This will be graded in conjunction with a talk given by the student on his topic. No further examination will be required for this section of the course, which will account for 50 marks.

Topics and assesments are to be submitted to the Head of the Department of Education."

No text-books are prescribed for this course. In contrast to most universities, the Mathematics Method Course is offered by lecturers of the Mathematics Department. There are several disadvantages of letting lecturers of the Mathematics Department of universities offer the Mathematics Method Course, instead of lecturers of the Education Faculty. The main disadvantage will be discussed later (see paragraph 6.1.2 (b)). At the University of Natal care is taken, however, to see that the students' criticism lessons are evaluated by lecturers of the Faculty of Education.

Techniques to make teaching practice and the Methods Courses more meaningful, such as mini-teaching and the use of the video-tape, was introduced in 1972 and is now practised exten= sively. Students are placed with teachers at schools during teaching practice. Students are expected to teach one or two periods a day and some of these lessons are attended by a lecturer from the university who awards a mark for this "criticism" lesson. The teachers with whom the students are placed are also expected to complete a form for each student reporting on the student's teaching practice. Form F1 (see Appendix) is that used by the lecturer when evaluating a criticism lesson while Form F2 (see Appendix) is that used by the teacher with whom the student is placed. A student will receive his teaching diploma only if he/she attains a satis= factory level of attainment in practice teaching.

At present (1974) there are 26 students in their fourth year of study taking the Mathematics Method Course out of a total of 172 UED students in their final year. Two of these students are enrolled for the UED (Non-graduate) while the rest, 24, already have attained their Bachelor's Degree. These figures are for the Durban and Pietermaritzburg centres combined.

4.2.3 The University of the Orange Free State

a. Introduction

At the above-mentioned university, students who wish to become teachers of Mathematics in the secondary school have a choice of two courses, namely the post-graduate University Education Diploma and the non-degree University Education Diploma. The post-graduate course is a one-year course while the non-degree course is a four-year partially integrated teacher's course.

b. Optional Mathematics Courses

(i) The post-graduate University Education Diploma

As is the case with all these post-graduate diplomas offered at the various universities, academic training is taken for granted and all the attention is focussed on the professional training of the prospective teachers. In order to attend the Didactics Method Course in Mathematics, students must have passed at least Mathematics II, the syllabus of which corresponds to that of the other universities. No pro= vision is made for a school-orientated Mathematics course which at the same time is recognised for ordinary degree purposes.

The Didactics/Methods Course in Mathematics will be discussed later under point d.

(ii) The non-degree University Education Diploma

This diploma course may be taken in one of seven different specializations. A prospective Mathematics teacher must choose the Science specialization, although a maximum of two scientific courses may be included in the General Course, as for example Biology I and Physiology I. As far as Mathematics is concerned no provision is made for a school orientated Mathematics course for prospective teachers. Prospective teachers must take Mathematics I in their first year, Mathe= matics II in their second year and Mathematics III in their third year. During the fourth year all the attention is focussed on the professional training of the student. The only difference between this University Education Diploma and the degree plus one year post-graduate diploma is that the required number of courses for degree purposes are not obtained in the non-degree course during the four years spent at the university. However, students completing this four-year diploma only require a few more courses for degree purposes and this provides an excellent incentive for them to study further afterwards. Considering that no provision is made for school-orientated courses in any of the subjects, it is doubtful whether any student not capable of obtaining a matriculation exemption pass at school will ever complete these four years at university successfully.

c. Mathematics Method Courses

The Subject Didactics or Methods Course is mostly presented by lecturers of the Faculty of Education and not by lecturers of the Mathematics Department. The syllabus for this course is as follows (47, p. 493):

Section A (50 marks)

1. Purpose, place and History of the subject at school.

2. Basic principles and specific methods in connection with the teaching of the subject with many practical examples.

3. General principles of method. This includes concepts like Induction and Deduction, from the known to the unknown and from the concrete to the abstract, self-activity, programmed teaching, the use of the language laboratory and purposeful= ness in teaching.

4. Teaching Aids: The textbook, the blackboard, films, strip films, the use of epidiascope and the tape recorder.

5. Practical experience in giving various types of lessons in the subject.

6. Drill, revision and remedial teaching in the subject.

7. Examining and evaluating the work of pupils at various stadia.

8. Methods by which independent study and critical thinking may be encouraged in pupils.

9. An analytical study of secondary school syllabuses and text=books for evaluation purposes, with special emphasis on -

   (a) the specific aim in including subject matter at various stages;

   (b) depth and span of subject matter at various stages;

   (c) integration of subsections so that pupils can see the subject in the correct perspective;

   (d) effectiveness of text-books.

10. A comparative study of the teaching of the subject in South Africa (the various Education Departments) and overseas.

11. Review of research being done in the teaching of the subject here and overseas.

12. The teacher of the subject: the qualities needed, his training and qualifications and the example he sets etc.

13. General:

   (a) The use of modern teaching aids;

   (b) The organization of the science laboratory;

   (c) Excursions - the proper organization of such excursions; and

   (d) The role, organisation and use of a subject library.

Of special interest to this study is the fact that the Univer=sity of the Orange Free State does not leave the teaching of the Subject Didactics entirely to the lecturers of the Edu=cation Faculty. Lecturers in the various subjects are also expected to touch upon the didactics of their subject under the following scheme (47, p. 496):

Section B (50 marks)

1. New developments and modern approaches in the subject.

2. The in depth treatment of topics which have bearing on teaching.

3. Special topics - special emphasis on second language treatment of topics.

4. Ways of encouraging independent studying and critical thinking in the subject.

5. Special emphasis on topics in section A and/or other aspects of the Subject Didactics in accordance with arrangements among the lecturers.

No specific books are prescribed for the above course.

Once again the danger of leaving the Subject Didactics section of the course to lecturers who are subject specialists must be pointed out. Unless the subject specialists, for example, the Mathematics lecturers, also have qualifications in Education, the importance of Subject Didactics is not appreciated and the lecturers tend to use the time to teach that which they are best qualified for, namely Mathematics content (see Paragraph 6.1.2 (b)).

At present (1974) there are six students in their fourth year doing the above Mathematics Method Course.

Teaching practice is arranged on the basis of students being sent out to various schools in the province and then being placed with a teacher. The teacher sends in a report on the student to the headmaster of the school who sends the reports of all the students at his school to the dean of the faculty of education of the university. Lecturers of the university periodically visit the students at the schools and evaluate criticism lessons given by the student. Form G_1 (see Appendix) is the form which the teacher with whom the student is placed is expected to fill in. Form G_2 gives a set of guide-lines along which it is suggested that the teacher should fill in the form. Form G_3 is filled in by the lecturer when evaluating the student's criticism lesson.

As far as could be ascertained aids such as the video-tape are being introduced to give a new dimension to teaching practice, as are techniques such as micro-teaching.

Teaching Practice as such is considered a subject in its own right. A student who therefore obtains a failing mark in Teaching Practice does not receive his/her teachers' certificate till the mark is improved on.

4.2.4 The Potchefstroom University for Christian Higher Education

a. Introduction

The above university offers two training courses for secondary school teachers namely a one-year post-graduate course and a four-year non-degree course.

b. Optional Mathematics Courses

(i) The one-year post-graduate course

As far as the above-mentioned course is concerned any person wishing to specialise in Mathematics simply takes the ordinary degree courses offered to all undergraduate students. The sylla= bus is as follows (34, p. 320):

Mathematics First Course:

Analytical Geometry: The straight line and the circle (rectangul= ar axes).

Algebra: Natural numbers and the principles of Algebra. The method of complete induction. Finite series. Permutations and combinations. The binomium for a natural exponent. Rational numbers. The quadratic form and the square root equation. Introduction to vector algebra. Complex numbers and their graphs. De Moivre's theorem for a whole exponent, with easy applications. Elementary theory of equations. Graphical representation of elementary algebraic functions.

Trigonometry: The trigonometric functions of any angle The addition theorems and trigonometric identities. Solution of triangles. Solution of equations.

Analysis: The irrational and real numbers (introductory). Limits. The sum of infinite series. The circumference and area of a circle. The radian. Minute values and limits of certain trigonometric functions. Elementary differential and integral calculus with easy applications. The cyclometric, exponential, logarithmic and hyperbolic functions.

Mathematics: Course II

Algebra: Partial fractions. Determinants of 2nd and 3rd order. Vector algebra with geometric interpretation and application. Linear dependency. Higher dimentional vector spaces. Linear equations with geometric interpretation in two and three dimensions. Determinants of higher order. The complete theorem of De Moivre with applications.

Analytical Geometry: Rectangular axes: The pair of lines. 2nd order graphs (easy equations). Pole co-ordinates: the equation of the straight line and conic sections. Homogeneous co-ordinates. The straight line. Linear dependency of points and straight lines. Desarques's theorem.

Analysis: Limit theorems and convergence (up to and including D'Alembert). Continuity. Continuity and differentiability of functions. The technique of differentiation, integration and partial differentiation - geometric interpretation. Series expansion. Ordinary differential equations of the first order and degree.

Mathematics: Course III

Algebra: Matrix algebra, Linear transformations and co-ordinate transformations. Characteristic roots and vectors of a matrix. Quadratic forms. The general second degree equation. Basic principles and results of group theory. Congruencies. The additive and prime class group modulo n. Definitions of a ring and a field. Deduction of simple properties of rings and fields.

Analytical geometry: The curves and area of second degree. The complex variable. The elementary functions. Analytical functions. Mapping.

Analysis: Partial differentiation with geometric applications. Maxima and minima. Taylor's series for more than one variable. Multiple integration with applications. Intro= duction of new variables. Regular continuity. The Riemann integral. Ordinary differential equations of a higher order and degree. Theory of real numbers. The general convergence criterium. Convergence of series. Regular convergence. Differentiation and integration of series.

(ii) The four-year non-degree teachers' training course

As far as the four-year non-degree teachers' training course at the University of Potchefstroom is concerned, the above-mentioned degree syllabus in Mathematics is completely ignored. Completely separate Mathematics courses have been devised specifically for the needs of the Mathematics teacher in the secondary school. These courses are named Secondary Mathematics 1A, Secondary

Mathematics 1B and Secondary Mathematics II. Secondary Mathe= matics 1A and 1B, each of which takes a year to complete ensures that the student who passes Secondary Mathematics 1B at the end of his second year is considered to be up to first-year degree standard. Secondary Mathematics II is a one-year course taken during the student's third year (which is considered to be) up to second-year degree standard. During the first two years the tempo is considerably slower than that of the normal first two years of undergraduate study so as to give the non-matriculation exemption candidates (who, according to a University spokesman, are very often only slow-developers) to orientate themselves. From experience the University has found that these students cope with the work quite easily after this initial orientation. For this reason the Secondary Mathematics II course is a one-year course done at a much faster tempo. The syllabuses for Secondary Mathematics 1A and 1B and also Secondary Mathematics II are as follows: Mathematics Secondary (a)
First Year (4 periods + 3 tutorials per week)

1. <u>Set theory</u>

(a) Basic theory: Finite and infinite sets, equal sets, equi= valent sets, empty sets, subsets, operations with sets.

(b) Sets of ordered pairs, the Cartesian product, relations, the range and domain of relations, graphs.

(c) Functions, one-to-one correspondence, inverse functions.

(d) Compound functions. Graphs of functions.

2. <u>Inequalities</u>

3. <u>Trigonometry</u>

(a) Measurement of angles in degrees. Positive and negative angles. General definitions of the trigonometric functions (circle functions); functions of compound angles. Graphs of the functions.

(b) Measurement of angles in radians.

$1 > \frac{\sin x}{x} > \cos x$, $\lim\limits_{x \to 0} \frac{\sin x}{x}$ and

$\lim\limits_{x \to 0} \tan x$. Applications.

(c) Inverse of the circle functions i.e. the cyclometric functions, graphs of the functions.

(d) Solution of trigonometric equations.

4. Algebra

(a) Mathematical induction

(b) Exponents. Proofs of the exponential laws (including proofs with rational exponents).

(c) Logarithms.

(d) Permutations and Combinations.

(e) The Binomial theorem and applications.

(f) Elementary series (finite and infinite), including the arithmetic, geometric and harmonic series. Convergence of the geometric and other simple series.

(g) Theory of equations.
The remainder theorem and factor theorem.
Symmetrical functions of the roots; Horner's method of finding the roots; place of real roots.

Mathematics Secondary 1(b)

Second Year (4 periods and 3 tutorials per week)

1. Number systems

Common bond and formal construction by means of classes of ordered pairs: natural numbers, whole numbers, rational numbers, real numbers, complex numbers. Applications and properties of each of these number systems.

2. Analytical Geometry

The straight line.
The circle.

3. Algebra

(a) The exponential and logarithmic functions and their graphs.

(b) Rational functions. $F(x) = \frac{f(x)}{g(x)}$ with $f(x)$ and $g(x)$ terms of grade 2. Determining the range and domain of F. Graph of F.

4. Analysis

(a) Limits.

(b) Continuity.

(c) Differential Calculus: Rules of differentiation. Differen= tiation of simple functions. Applications, maxima and minima.

(d) Integral Calculus: The integral as limit of a sum. Inter= pretation of the integral as area under a curve. Integra= tion as the inverse of differentiation. Integration of familiar and other functions.

Secondary Mathematics 2 (Third Year) (8 periods per week):

Partial fractions.

Linear Algebra: Vector spaces. Systems of linear equations; matrices. Determinant of a matrix. Matric algebra.

Abstract algebraic structures: Groups, rings, fields, vector spaces. Finite structures; systems of remainder classes in the ring of whole numbers. Algebraic operations with remainder classes (modulo arithmetic).

Complex Numbers: De Moivre's Theorem for rational exponents. Applications.

Geometry in three dimensions using vector methods; the straight line and the plane.

Analytical Geometry: Two dimensional: Conic sections; Three dimensional: the sphere and other central second degree areas.

Differentiation of trigonometric and cyclometric functions. Specific integrals. Taylor's theorem. Hyperbolic functions.

Convergence of sequences.

Method of Secondary Mathematics.

Method of Secondary Mathematics (Fourth Year):

Linear transformations in a vector space. The core and mirror image space of such a transformation. The matrix of a trans= formation. Synthetic Geometry, including an introduction to projective geometry.
Partial differentiation.
Functions of a complex variable.
Method of Secondary Mathematics.

c. Mathematics Method Courses

After completing the Secondary Mathematics II at the end of his third year of training, the student who specialises in Mathe= matics has to take the Methods Course in Mathematics during his fourth and final year. As the first group of students following this new four-year diploma course were only in their second year the syllabuses for their courses almost two years in the future were understandably not yet finalised. However, four periods a week are being set aside for all the Methods Courses in the fourth year and it is most probable that the Methods Course in Mathematics will to a large extent resemble that which was compiled for the Transvaal Education Department's In-service Training Mathematics Methods Course. The following is a general scheme to be used as guide-line for all Methods Courses (34, p. 386):

1. Ways of viewing the subject - the Christian viewpoint.

2. Methodology of the subject (1 and 2 only with those subjects where applicable).

3. Aims and purpose of teaching the subject at the Secondary School.

4. The history of the teaching of the subject at the Secondary School.

   (a) Overseas (Western Europe and America).
   (b) In South Africa.

5. Psychological principles for the teaching of the subject.

6. Methodology of teaching:

   (a) Methods.
   (b) Use of teaching aids.

(c) The choice and use of a good textbook.

7. The syllabuses Std VI – X: getting to know the syllabuses and learning how to set up schemes of work for a year.

8. The subject teacher.

9. The use of the school library in teaching the subject.

10. The care and organization of a laboratory.

11. Examining.

During practice teaching criticism lessons are evaluated by members of the Faculty of Education and not by members of the different academic departments. The prospective Mathematics teacher is therefore evaluated by a person who has some knowledge of the aims and Didactics of Mathematics and who himself has had experience of school teaching. However, lecturers of the Mathematics Department are also expected to evaluate one or two criticism lessons in order to orientate themselves with respect to the teaching of Mathematics in the schools (See Form J in the Appendix).

4.2.5 The University of Pretoria

a. Introduction

The University of Pretoria also offers two main training courses for secondary school teachers, namely a one-year post-graduate course and a four-year non-degree course and as from 1974 a four-year B.A.

b. Optional Mathematics Courses

(i) The one-year post-graduate course

This course is only open to those students who have at least a Bachelors' degree and furthermore satisfy the stipulations of the Criteria for the Evaluation of South African Qualifications for Purposes of Employment in Education (37) with regard to subject groupings. As far as the prospective Mathematics teacher is concerned, it is deemed necessary that he should have passed at least two years of degree Mathematics in order to attend the Mathematics Didactics Course during the post-graduate professional year.

(ii) The Baccalaureus Artium Educationis or Scientiae Educationis (B.A. (Ed.) or B.Sc. (Ed.))

The above degrees are new additions to the Faculties of Arts and Science at the University of Pretoria. It is interesting to note that these degrees do not resort under the Faculty of Education at this university but under the Faculties of Arts and Science as mentioned above. Persons wishing to enrol for either of these degrees must be in possession of a Matriculation Exemption Certificate. The degree course is spread over four years. During the first year at least three first-year subjects, which are recognised as school subjects, must be passed before the student is permitted to enter the second year of study. Pedagogy I and at least two second-year courses, of which one must be in a school subject, must be passed to gain admittance to the third year of study. During the third year of study Pedagogy II and at least two third-year courses, once again of which one at least must be in a school subject, must be passed. During the fourth year the professional side of the course commences and Pedagogy III and Subject Didactics in the student's main academic subjects. A student wishing to specialise in Mathematics must take Subject Didactics: Mathematics. The syllabus for this course is exactly the same as that of the one-year post-graduate diploma and, in fact, will probably be attended by both groups simultaneously, and possibly even by those students enrolled for the four-year non-degree secondary teacher's diploma specialising in Mathematics. The syllabus will, however, be discussed under point e.: Subject Didactics. Mathematics may be taken as main subject in either the B.A.(Ed.) or B.Sc.(Ed.) degrees.

(iii) The four-vear non-degree Higher National Education Diploma (HNED)

As is the case at the other universities, non-matriculation exemption students are eligible for this course which is a combined academic-professional course. The first two years of study is devoted entirely to the academic side of the training. During the third and fourth years the professional courses are done, although the academic training continues so as to enable the students to complete the necessary eight degree courses (37, p. 37). In contrast to the B.A. (Ed.) and B.Sc. (Ed.) degrees the HNED (non-degree) resorts under the Faculty of Education. The complete four-year course is arranged as follows (49, p. 16):

First Year:

(1) Afrikaans I or Afrikaans IB

(2) English (IA or B) or any other approved school subject.

(3) Pedagogy I.

(4) At least one other approved school subject at first-year level.

Second Year:

(1) Pedagogy II.

(2) One of the subjects chosen under (1), (2) or (4) in the first year to be taken at second-year degree level.

(3) Two other qualifying courses not yet taken.

Third Year:

(1) Religious Instruction.

(2) Demonstration of lessons.

(3) Pedagogy III.

(4) One qualifying second-year course started under (3) of the second year.

(5) Teaching Practice.

(6) Subject Didactics: (a) First school subject.
(b) Second school subject.

Fourth Year:

(1) Blackboard work and writing (Semester course).

(2) Art or School music.

(3) Demonstration of lessons.

(4) Teaching aids (including the integration of the school library).

(5) Teaching Practice.

(6) School organization and administration.

(7) Subject Didactics (to Std 10 level).

(8) Subject Didactics (to Std 8 level).

(9) Coaching of sport.

(10) Speech training: Afrikaans and English.

Mathematics naturally figures prominently as a school subject. However, a student who wishes to specialise in Mathematics, either as first school subject or as second school subject, has no option but to do the first-year or second-year degree courses in Mathematics. Once again the problem of mostly non-matriculation exemption students doing highly theoretical courses arises. The syllabuses for the first-year and second-year courses in Mathe= matics which the four-year non-degree students may follow, are exactly the same as those followed by first-year and second-year undergraduates.

c. Subject Didactics

As far as the Subject Didactics of Mathematics at the University of Pretoria is concerned, the current position is that a Subject Didactics course for Mathematics for the four-year non-degree student teachers is not being offered. This is so because the training course has only been in operation since 1972 with the result that there are no third-year students in the course yet. A university spokesman, however, indicated that the Faculty was contemplating changing the curriculum in such a way that the Subject Didactics would not be spread over the third and fourth years as the Yearbook showed, but that it would be a one-year course only done in the fourth and final year. The reason for this is that so few HNED (non-degree) students are expected to pass the Mathematics I and Mathematics II degree courses that one Subject Didactics class combining these few students with the one-year post-graduate students and the B.Sc. (Ed.) students would be preferable. As yet the University does not contemplate the introduction of Mathematics courses which are more school-orientated to fulfill the needs of prospective Mathematics teachers. The syllabus envisaged for the fourth year is as follows:

SUBJECT DIDACTICS: MATHEMATICS

1. The present approach. Some psychological theories.

2. The Structure of the lesson (content, form, didactical modalities and the course of the lesson).

3. Syllabus and schemes of work.

4. Subject policy (aims, class-room practice, revision and evaluation).

5. Study of topics, analysis of faults and the design of lessons.

6. Textbooks (evaluation and use).

This course is presented solely by members of the Faculty of Education, quite independent of the Mathematics Department of the University. The main prescribed book for the above course is: OOSTHUIZEN, W.L. Leerstofreduksie in die Wiskundeles. McGraw-Hill, 1973.

Because of the fact that the Subject Didactics for Elementary Mathematics and for Mathematics is the responsibility of the Faculty of Education alone, lecturers of this Faculty are alone responsible for the evaluation of criticism lessons. Form H (see Appendix) is the form used for this evaluation and is remarkable in that specific points are not listed for the lecturer's consideration as he evaluates a student's lesson. Teachers with whom the students are placed are consulted by the lecturers concerned before the report is completed.

Teaching Practice is regarded as a separate subject. This means that the marks for a criticism lesson in Mathematics are not included in the Mathematics mark. A student must obtain a pass mark in at least six criticism lessons to pass in the subject Teaching Practice (see Form H in Appendix). In the event of a student not passing this subject the student cannot receive the teaching diploma.

The University of Pretoria has recently acquired the necessary apparatus for making video-tapes of lessons given by students. "Micro-teaching" (mini-teaching) is being experimented with on a small scale in that a student is given the opportunity to teach a group of pupils for a short while. Afterwards the video-tape of the student's teaching is discussed by the other students and the lecturer. However, this experiment is by no means done on the scale on which it is being done by American universities.

4.2.6 Rhodes University

a. Introduction

The University of Rhodes offers the following diplomas by means of which a student can qualify to teach Mathematics in the secondary school: The National Higher Education Diploma (Graduate) (NHED) and the National Higher Education Diploma (Non-graduate) (NHED). The first-mentioned diploma is a one-year post-graduate diploma while the second is a four-year non-graduate diploma.

b. Optional Mathematics Courses

For both these diplomas students wishing to specialise in Mathe= matics must take the standard degree courses in Mathematics for at least two years to qualify to teach pupils up to Std 10. No specific school-orientated Mathematics course is provided for students enrolled for the four-year non-graduate diploma. Students enrolled for the four-year non-graduate teaching diploma furthermore, must pass the normal Mathematics I and Mathematics II degree courses with the usual 50 per cent. The syllabuses for Mathematics I and II are as follows (36, p. 207):

"MATHEMATICS

Course IA (Major Course) (2 papers)

Algebra: Equations and inequalities; summation of series; binomial theorem; permutations and combinations; partial fractions; rational functions; sets and functions; the real number system. Complex numbers; de Moivre's theorem.

Geometry: the straight line, circle and conic sections.

Trigonometry: circular functions of angles of any size; addition theorems; identities; solutions of equations; inverse trigonometric functions.

Calculus: Differentiation and integration of polynomials, rational functions, logarithmic and exponential functions, trigonometric and hyperbolic functions and their inverse functions. Extrema. The definite integral. Integration by use of sub= stitution and partial fractions; integration by parts. Methods of integration. Applications to areas, volumes and arc-lengths. Sequences and series. Partial differentiation.

Recommended Textbooks:

G.B. Thomas: Calculus and Analytic Geometry, Vol. 1 (Addison-Wesley Publishing Co.)

J.V. Robinson: Modern Algebra and Trigonometry. (McGraw-Hill)
H.J. Schutte and L. Lobb: Analytic Geometry (available from Mathematics Dept. Secretary)

DEPARTMENT OF MATHEMATICS (PURE)

Course II (2 papers)

Algebra: Linear algebra: rank of a matrix, determinants, solutions of equations, vector spaces.

Geometry: the plane and straight line; vectors.

Analysis: Elementary integration and applications; inequalities and limits; elementary properties of sets on the real line; functions of a real variable; continuity and differentiability; functions of n variables; partial differentiation; Taylor series for one and many variables; maxima and minima; improper integrals; multiple integrals; convergence of series; volumes and areas. Differential equations."

It is significant that at present (1974) there are no students doing Mathematics I or Mathematics II who are enrolled for the four-year National Higher Education Diploma (non-graduate), while there are 7 students doing the fourth-year post-graduate Mathematics Method Course.

c. Mathematics Method Courses

Students enrolled for the National Higher Education Diploma (Graduate) and (Non-graduate) follow the same Mathematics Method Course during their respective fourth year of study. This Methods Course is the responsibility of the Faculty of Education and as such is presented by lecturers of this faculty. As has already been mentioned at least two years of Mathematics is the minimum requirement for this course. The syllabus for the course is as follows(36, p. 324):

"MATHEMATICS

(1) The main reasons for the inclusion of Mathematics in school.

(2) The psychology of learning applied to the learning of Mathematics.

(3) Sets. Teaching set language and its applications to school Mathematics.

(4) Geometry. The history of, and the reasons for, the declining position of Euclidean geometry as a school subject. The present position of Euclidean geometry in South African schools. Stage A, B and C approach to geometry as suggested by the "Reports on the Teaching of Geometry in Schools" prepared for the Mathematical Association of the United Kingdom.

The beginnings of non-Euclidean geometries - Riemannian and Lobachevskean. Transformation and co-ordinate geometry as an alternative to Euclidean geometry, e.g. Southampton Project.

(5) Arithmetic. Discussion of an axiomatic approach to primary school arithmetic, e.g. School Mathematics Study Group Project. The use of structural apparatus, including Cuisenaire Rods and multibasic blocks and Dienes Algebraic Experience Material, throughout the school.

Discussion of:

1. Development of the number line to include all real numbers.
2. Percentages, including profit and loss problems.
3. The proofs of elementary arithmetical rules.
4. Ratio and proportion.
5. Mensuration.

(6) Algebra. Discussion of:

1. Algebraic notation.
2. Functions.
3. Graphical Work.
4. Inequalities and equation.
5. Indices and logarithms.
6. Binary Arithmetic, flow-diagrams and computers.
7. Linear Programming.
8. Statistical methods.

(7) Trigonometry.

1. Introduction to trigonometrical ratios.
2. The order in which ratios are to be taught.
3. The general angle.
4. Trigonometric proofs.

(8) Mathematical Projects.

A survey of the following Mathematical Projects is made

1. The School Mathematics Project - Southampton University.
2. The Midlands Mathematical Experiment - Worcester Training College.
3. The Psychology and Mathematics Project - Manchester University.
4. Projects in the USA - (i) Madison; (ii) Illinois; (iii) School Mahtematics Study Group.
5. The Scottish Experiment.
6. The St. Dunstan's booklets."

No textbooks are prescribed for the above course. Cyclostyled notes are issued to the students whenever it is considered necessary to do so. As mentioned previously there are at present 7 students, all graduates, who are following this course. The total number of students enrolled for the NHED (Graduate) in their fourth year is 59. Few students seem to be interested in the NHED (Non-graduate) as there are at present 3 students enrolled for this diploma in their first year of study, 8 in their second year, 5 in their third year and 4 en their fourth year. Not one of these students are, however, doing Mathematics. Students in their third and fourth years of study at present (1974) are students who have failed one or two subjects while doing the NHED (Graduate) and have simply switched over to the NHED (Non-graduate). This will to a large extent also be true of the first and second year numbers as regards the NHED (Non-graduate) because of the fact that a matriculation exemption pass is required by the University for admission to the NHED (Non-graduate). Students will obviously then rather try to obtain a degree and do the one-year post-graduate diploma than enrol for the NHED (Non-graduate) from the outset since there is hardly any difference in the courses required or the standard expected between the NHED

(Graduate) and the NHED (Non-graduate). Those students who fail a course or two and find themselves short of the required number of courses for degree purposes then simply change over to the Non-graduate diploma.

c. Teaching Practice

Since the Mathematics Method courses are presented by lecturers of the Faculty of Education the teaching practice criticism lessons are also taken care of by these lecturers. In general the teachers at the schools with whom the students are placed on teaching practice evaluate the students' lessons. The teachers give their reports to the headmaster who collates them and sends them to the University. The lecturers then study these reports and write a general criticism, a copy of which goes to the student. Some of the aspects the lecturers pay attention to are shown in the following lesson plan:

"Student's name: ....

Name of Proposed Lesson:
Aim of Proposed Lesson:
Pupil's previous knowledge:
Very brief description of Content to be covered or Skills to be learned:

STAGES OF DEVELOPMENT OF LESSON:

Suggested Timing of Lesson	Lead-in to Lesson	Form of Class Organisation e.g. Group Work	Pupil Activity during the Lesson	Integral part played by Aids e.g. Audio-Visual	Recapitulation at any stage
$\frac{1}{4}$-way					
$\frac{1}{2}$-way					
$\frac{3}{4}$-way					
End					

OWN EVALUATION OF LESSON:

The Teaching Practice mark is given as a separate mark, as for any other subject, and if a student obtains a failing mark for Teaching Practice his/her teaching diploma is withheld. From May the next year the student can do a further teaching test in order to improve his/her teaching mark and qualify for certifi= cation. On the whole it can be said that the teaching practice is approached in the traditional manner of a student being placed with a teacher who evaluates a few of the student's lessons and sends a report back to the University. At present "modern" experiments such as micro-teaching and the use of the video-tape are being used to an increasing extent. Micro-teaching especially is proving to be of great aid in training students in the art of teaching their subject.

4.2.7 The University of South Africa

The University of South Africa is little affected by the new legislation as regards the initial training of secondary school teachers. Only one diploma course is offered, namely the Uni= versity Education Diploma (UED) which is a one-year post-graduate diploma. This diploma compares with the one-year post-graduate teaching diplomas offered by the other universities except that no teaching practice as such is arranged by the University. A graduate who wishes to obtain the UED must either have another teaching diploma already, or must teach for two full school terms. In practice it therefore happens that graduate teachers in the schools who do not have professional qualifications mostly enrol at UNISA for the UED in order to be raised to a higher category for promotion and salary purposes.

The new legislation as regards teacher training is going to affect the University of South Africa in another most important field of teacher-training, however, and that is the field of further and in-service teacher training. Because this is such an important aspect of teacher training, further and in-service teacher training will be discussed under a separate heading where the University of South Africa's rôle will be more fully explained (see paragraph 4.2.12).

4.2.8 The University of Stellenbosch

a. Introduction

Two secondary teachers' diplomas are offered at the University of Stellenbosch at present, namely the Sekondêre Onderwysdiploma (SOD) and the four-year SOD which is a non-graduate diploma. The University does not have four-year combined academic and profes= sional degrees (B.A.(Ed.) or B.Sc. (Ed.)) as yet, but the possibility of instituting these degrees is being investigated.

b. Optional Mathematics Courses

(i) The one-year post-graduate SOD

In order to be admitted to the above course a student must be in possession of at least a Bachelor's degree. Prospective Mathematics teachers must have at least Mathematics II to their credit before being allowed to follow the specialisation course in Mathematics as first teaching subject. The Mathematics I and Mathematics II courses required are similar to those presented at the other universities. No provision is made for a more school-orientated Mathematics course which would be more suitable for Mathematics teachers.

(ii) The four-year non-graduate SOD

The above diploma may be obtained in one of the following fields: Arts, Science, Commerce or Physical Education. The minimum admission requirement for this diploma is the Secondary School Leaving Certificate and the first three years of study are de= voted entirely to academic study. During these three years eight academic courses, as prescribed for degree purposes, must be successfully completed. No courses may be carried during the fourth year of professional study and at least five courses must be in subjects which are considered to be secondary school subjects.

Prospective Mathematics teachers who have enrolled for this four-year SOD must pass at least Mathematics II, the same course as for degree purposes. However, these students are treated more leniently as regards the pass-requirements: In order to pass, a year mark of 40 per cent is required for Mathematics III instead of the usual 50 per cent, and at least 50 per cent for the examination mark. Degree students must obtain at least 50 per cent for both the year mark and the examination mark.

c. Mathematics Method Courses

The curriculum for the entire fourth year of professional study is the same for both the graduate and non-graduate SOD diplomas as far as Arts and Science students are concerned. This also applies to the Subject Didactics course in Mathematics. The students of both diploma groups attend the same lectures. The syllabus for the Subject Didactics (Mathematics) course is as follows:

1. Interpreting a syllabus.
2. The use of a textbook.
3. Demonstration lessons - students and the lecture.
4. The setting of examination papers and memoranda.
5. The lesson phases (practical).
6. The application of didactical principles in Mathematics e.g. purposefulness motivation, planning, lived experience, self-activity, insight and problem solving, evaluation.
7. Each student must help a weak pupil from the neighbourhood.
8. Study in depth of the background of school Mathematics.

Two lectures per week and one practical lesson is set aside for the above Subject Didactics course in Mathematics. The course is presented by lecturers of the Faculty of Education and not by lecturers of the Mathematics Department. Similarly criticism lessons of students on teaching practice at schools in the vicinity of Stellenbosch are evaluated by lecturers of the Faculty of Education. Students who are further afield have their criticism lessons evaluated by the teacher with whom they have been placed and by the headmaster of the school (see Form M in the Appendix).

The University of Stellenbosch has an arrangement similar to that of the University of Cape Town, whereby two days per week are set aside for teaching practice either at the neighbouring schools or at the University to which pupils are brought. A teaching Practice Centre for this purpose has been established at the University. Audio-visual education, micro-teaching and discussion of lessons are done at this centre, giving prospective teachers a thorough preparation in the practical side of teaching.

4.2.9 The University of Port Elizabeth

a. Introduction

The University of Port Elizabeth offers three separate teachers' training courses for secondary school teachers, where most of the other universities only offer two (see Table 4.3). The three courses are the Baccalaureus Artium or Scientiae (Secondary Education) (B.A. (Sec.Ed.) and B.Sc.(Sec.Ed.)), the one-year post-graduate Higher National Education Diploma (HNED) and the four-year non-degree Higher National Education Diploma (HNED).

b. Optional Mathematics Courses

(i) The Baccalaureus Artium or Scientiae (Secondary Education), (B.A. (Sec.Ed.) or B.Sc. (Sec.Ed.))

These degrees are four-year degrees and combine the professional training of the teacher with the academic training for a degree. It is important to note that these degrees are in no way inferior to any of the other degrees and that they qualify a student for post-graduate study in the faculties concerned, namely the Faculty of Arts, Science and Education.

As far as the training of Mathematics teachers is concerned, the B.Sc. (Sec.Ed.) and B.A. (Sec.Ed.) caters well for the needs of the prospective Mathematics teacher and the needs of the schools starved of Mathematics teachers. Student teachers enrolled for the B.Comm.(Sec.Ed.) degree may also take Mathematics during their first and second years of study. Prospective teachers taking the B.Sc.(Sec.Ed.) degree have the choice of four main courses: Course I with Physics as major; Course II with Chemistry as major; Course III with Mathematics as major and Course IV with Applied Mathematics as major. Apart from Course III with Mathematics as major subject, the other three courses require that Mathematics must be passed at second year level at the very least. In short, any prospective teacher enrolling for the B.Sc.(Sec.Ed.) degree will necessarily have at least two years of Mathematics to his credit when he graduates. In order to gain an impression of the extent of the curricula, the curriculum for the B.Sc.(Sec.Ed.) with Mathematics as major will be given in full (48, p. 162):

Curriculum 3: Mathematics major

First Year

1. Mathematics I.
2. Two of Physics I, Chemistry I or Applied Mathematics I.
3. Education 1A (Writing and Blackboard work; School Library).

Second Year

1. Mathematics II
2. One of Physics II, Chemistry II or Applied Mathematics II.
3. Pedagogics I.
4. Education 1B (Education policy; Audio-visual Education, Sports coaching and/or School Clubs).
5. Teaching Practice.
6. Professional Afrikaans I or Professional English I.

Third Year

1. Mathematics III.
2. Pedagogics II.
3. Methodology of Mathematics.
4. Education 1C (Religious Instruction, Administration, Speech training).
5. Teaching Practice.
6. The Natural Sciences and the Modern Civilization I.

Fourth Year

1. One of the Physics III or Chemistry III or Applied Mathe= matics III.
2. Pedagogics III.
3. Methodology of the second school subject.
4. Education 1D (Language medium teaching).
5. Teaching Practice.

The Mathematics syllabuses for the respective courses mentioned above are as follows (48, p. 213).

<u>Mathematics I</u>

First Semester

(a) Elementary Set Theory, the real number system, inequalities. The concept of a function. Finite series. The concept of a limit. Elementary differential and integral calculus. The trigonometric functions and their inverse functions, polynomials and rational functions. Introductory vector algebra and vector geometry.

(6 lectures and 2 tutorials a week)

Second Semester

(b) Elementary differential and integral calculus continued. The exponential and logarithmic functions. Permutations and combinations, the Binomial theorem, the theory of equa= tions. Complex numbers. Analytical Geometry of the straight line and the circle.

(6 lectures and 2 tutorials a week)

Mathematics II

First Semester

(a) Algebra of abstract sets, images, sets of real points, Conic sections.

(b) Geometry of vectors, vector spaces, matrices, linear equations, determinants.

(6 lectures and 2 tutorials a week)

Second Semester

(c) Number theory. Functions of a real variable, continuity, differentiability, middle value theorem and applications. The theory of specific integrals. Infinite series. Complex functions. Functions of multiple unknowns, partial differen= tiation, the complete differential.

(6 lectures and 2 tutorials a week)

Mathematics III

First Semester

(a) Set theory, countability, Metric spaces. Convergence, compactness. Functions of a real variable. Regular con= vergence. Integration.

(3 lectures and 1 tutorial a week)

(b) Linear algebra and geometric applications.

(3 lectures and 1 tutorial a week)

Second Semester

(c) Analytical functions, Cauchy's theory (3 lectures and 1 tutorial a week).

(d) Groups and rings: introductory theory (2 lectures and 1 tutorial a week).

(e) Linear differential equations (1 lecture a week).

A university spokesman indicated that the B.A. (Sec.Ed.) and B.Sc.(Sec.Ed.) courses were not finding much favour with the students. Apparently the students prefer to complete their degree studies first and then specialise in teaching during their fourth year. This could be because of the students wishing to preserve their independence by acquiring a degree which is recognised in all walks of life, whereas the Education degree is seen as an attempt to ensnare them in Education.

At present (1974) there are 16 students enrolled for the B.A. (Sec.Ed.) degree and one for the B.Sc. (Sec.Ed.) degree who are in their first year of study. Of these one student has enrolled for Mathematics I. (There are, however, six students doing Mathematics I who have enrolled for the B.Com. (Sec.Ed.) degree.) As regards the second-year group, there are five students enrolled for the B.A. (Sec.Ed.) degree, none for the B.Sc. (Sec.Ed.) degree and three for the B.Com. (Sec.Ed.) degree of which only one B.Com. (Sec.Ed.) student is doing Mathematics II.

(ii) <u>The one-year post-graduate Higher Education Diploma</u>

This diploma is open to all students who have obtained a Bachelor's degree, subject to the stipulations of the Criteria for the Evaluation of South African Qualifications for Purposes of Employment in Education (37) as regards the number of school subjects that should be taken for degree purposes. As is the case at all the other universities offering this diploma, the academic preparation of the students is taken for granted and all the time is spent on the professional training of the aspirant teachers. Prospective Mathematics teachers must have passed at least Mathematics II, the syllabus of which has already been mentioned in the previous paragraph. Most of the students prefer to take their degree first and then follow it up with this one-year post-graduate Diploma.

(iii) <u>The Higher Education Diploma (non-degree)</u>

Students enrolling for the above diploma may specialise in one of several directions such as Human Sciences, Natural Sciences, Economic Sciences and Physical Education among others. Students who wish to specialise in Mathematics as teaching subject may enrol for the HED with specialization in either the Human Sciences, Natural Sciences or Economic Sciences. Although the minimum admission requirements for the above diploma are simply a school leaving certificate (Std 10), students who wish to take Mathematics must have passed it at the higher Matriculation Exemption examination. The following is the curriculum of the HED (Natural Sciences) which prospective Mathematics teachers are most likely to enrol for (48, p. 192):

"H.E.D. (Natural Sciences)

CURRICULUM 1 (Physical and Mathematical Sciences)

<u>Year of Study</u>	<u>Subject</u>
First	Physics 1 Mathematics 1 Chemistry 1 Educational Practice 1A: Sports Coaching/Sports Coaching and School Organisations; School Librarianship, Writing and Blackboard Work Professional Afrikaans 1 <u>or</u> English Special 1
Second	<u>One of</u>: Physics 2/Mathematics 2/ Chemistry 2 Pedagogics 1 Educational Practice 1B: Educatio= nal Policy Practical Teaching
Third	<u>One of</u>: Physics 2/Mathematics 2/ Chemistry 2 Pedagogics 2 Method of First School Subject Educational Practice 1C: Audio= visual Education: Speech Training Practical Teaching.
Fourth	<u>One of</u>: Physics 2/ Mathematics 2/ Chemistry 2 Pedagogics 3 Method of Second School Subject Educational Practice 1D: Adminis= tration of Education; Language medium tuition; Religious Instruc= tion Practical Teaching."

As can be seen from the above curriculum students enrolled for the HED who wish to take Mathematics must take the degree course in Mathematics. There is no other Mathematics course specifically for student teachers and no such course is being contemplated for the near future. At present (1974) there is only one student enrolled for the HED (non-degree) who is taking Mathematics I.

c. <u>Mathematics Method Courses</u>

Especially as regards the B.Sc.(Sec.Ed.) and B.A.(Sec.Ed.) degrees, but also including the one-year post-graduate Diploma, the Subject Didactics or Methods Courses are offered by the lecturers of the subject concerned. This means that the Didactics or Method of Mathematics is given by lecturers of the Mathematics Depart= ment and not by lecturers of the Education Faculty. This system has several disadvantages (see Paragraph 6.1.2 b.), chief of which is the tendency of the Mathematics lecturers to regard the Didactics of their subject as a pure waste of time with the result that they use the time set aside for Didactics to give extra lectures in Mathematics. At the University of Port Elizabeth, however, one suspects that this is simply an organisational matter seeing that the lecturers doing this work have long years of teaching experience in secondary schools and were specifically appointed for the didactical side of the training of Mathematics teachers. At any rate, seeing that the disadvantages of this practice will be fully discussed under paragraph 6.1.2 b. no more will be said here. The following is the syllabus for the Method of Mathematics course in broad outline:

"METODIEK VAN WISKUNDE: PEW I

Doelstellinge met die onderrig van wiskunde op skool; studie van die inhoud van die sillabusse vir die sekondêre skool en van die metodes en onderrigtegnieke eie aan die vak; toetsing en evaluering, remediëring; vakliteratuur en vakverenigings; verdere agtergrond studie: capita selecta (bv. formele logika.)"

Three periods per week are set aside for this course and it is intended for students enrolled for the one-year post-graduate diploma, the professional degree course, B.A.(Sec.Ed.) and B.Sc.(Sec.Ed.), and the four-year non-degree diploma course students. At present there are 10 students doing the Method of Mathematics course, all of them post-graduate students as the other courses have not been in operation long enough to yield students for this Methods course. Because of the lack of suitable Methods books for the South African situation, no books are prescribed, but students have to read books and magazines in order to do the projects which they are given.

It is the practice at the University of Port Elizabeth for the lecturers of not only the Faculty of Education but also of the

Mathematics Department to evaluate the criticism lessons of their students on teaching practice. As will be explained under Paragraph 6.1.2 b., the lecturers of the Mathematics Department are mostly specialists with high qualifications in their subject Mathematics but who usually have not had any experience of teaching in a secondary school or any other knowledge of the Didactics of Mathematics. However, this will be more fully discussed under the above-mentioned Paragraph 6.1.2 b.

The lecturers use Form K (see Appendix) when evaluating the criticism lessons of the students.

As far as could be ascertained modern methods of giving students experience in presenting lessons such as making use of video-tapes and organising micro-teaching (mini-teaching) lessons are not implemented (see 5.1.3 b.). The emphasis is still on the traditional theoretical aspects of teacher training with a three or four weeks set aside per year for teaching practice.

Students are expected to give at least two lessons per day during teaching practice. The teaching staff at the schools evaluate roughly fifty per cent of the students' criticism lessons while the rest are evaluated by the visiting lecturers who are from both the Mathematics Department and the Faculty of Education. (Prospective secondary school teachers are as far as is possible evaluated by members of the Mathematics Department.) Teaching Practice is regarded as a separate subject in which the student's two main teaching subjects' methods courses are included. The students have to obtain fifty per cent in each of these two sections and failing to accomplish this they have the choice of either registering for a further three months at the University during which they follow a teaching practice programme, or they may be appointed at a school in a temporary capacity till they have been retested and passed Teaching Practice.

4.2.10 The Rand Afrikaans University

a. Introduction

The Rand Afrikaans University, like the University of Port Elizabeth, is a new university which came into being during the late nineteen sixties. Like the University of Port Elizabeth, the Rand Afrikaans University does not cater for the training of primary school teachers at all. Both these universities, how= ever, are unique in this way that they provide a four-year combined degree and professional training course for secondary school teachers known as Baccalaureus Artium (or Scientiae) in

Education, B.A. (Opv.) or B.Sc.(Opv.). The usual one-year post-graduate secondary teachers' training course and the four-year non-degree course are also offered. Because the University is still young, it has relatively few students. At present use is made of temporary rooms and offices while the new campus is being erected in Auckland Park.

b. Optional Mathematics Courses

(i) The Baccalaureus Artium or Scientiae (Education) B.A. (Ed.) or B.Sc.(Ed.)

The B.A. (Ed.) and B.Sc. (Ed.) degrees are proving to be popular with the students, according to a University spokesman. He could not say whether this was because of the Transvaal Edu= cation Department tending to favour students taking these degree courses above students taking the degree and one-year post-gradu= ate course as far as bursaries are concerned.

As regards the training of Mathematics teachers the B.Sc (Ed.) curriculum has this disadvantage at present that the students take Mathematics I during their first year but only carry on with Mathematics II in their third year. The syllabuses for Mathematics I, II and III differ in no way from the degree courses in Mathematics and are as follows (35, p. 239):

Mathematics 1A (Semester course)

Sets, relations and functions. Limits. Differentiation, Continuity. Related tempo's, maxima and minima, convexity and turning points, curve sketching. The trigonometric, exponential and logarithmic functions. The integral. Integration techniques. Area under a curve, the length of a curve, area and volume of revolution.

Mathematics 1B (Semester course)

Inequalities. Series. The Binomial theorem. Complex numbers. Polynomials and algebraic equations. Trigonometric equations. Straight lines and circles in a plane. Vectors. Planes, lines and spheres in space. Conic sections.

Mathematics IIA (Semester course) Mathematics 1B a prerequisite.

n-Dimensional vector spaces and linear transformations. Matrix algebra. Determinants. Systems of linear equations. Vector geometry.

Mathematics IIB (Semester course) Mathematics 1A, and IIA a 40 per cent prerequisite.

Functions of two or more unknowns, most important properties. Partial differentiation. Cylinder- and sphere co-ordinates. Multiple integrals. Line integrals. Green's theorem for a plane. Convergence of series. Elementary theory of differential equations.

Mathematics IIIA (Semester course) Mathematics IIA a prerequisite.

Set theory. Elementary topological concepts. Convergence of point and function series. Regular convergence. Properties of continuous functions, regular continuity. Series, term by term differentiation and integration. The Riemann-Stieltjes integral.

Mathematics IIIB

Groups, Rings. Integration domains. Fields. Vector spaces. Extension of the number concept from Peano's axioms to the rational numbers.

Mathematics IIIC (Mathematics IIA is a prerequisite)

Special functions: Beta, Gamma, Bessel. Fourier series. Laplace transformations.

As has already been mentioned, no school-orientated course in Mathematics is available although a University spokesman said that he found that students with Mathematics III often had not even heard of the Binary system.

(ii) <u>The one-year post-graduate diploma in teaching</u>

This diploma once again is open to students who are already in possession of a Bachelor's degree which satisfies the conditions laid down in the Criteria (37). During this one year all the emphasis is on the professional training of the prospective teachers. As far as the Mathematics teacher is concerned, two years of Mathematics successfully completed is the minimum for him to be able to attend the Mathematics Didactics class.

(iii) <u>The four-year non-degree secondary teacher's diploma</u>

As far as this diploma course is concerned, nothing is being done as yet with regard to the training of Mathematics teachers. A University spokesman indicated that the University had taken over the secondary teacher training programme of the Goudstad Teachers' Training College, and this programme made no provision for Mathematics. This College apparently had not trained Mathe= matics teachers because of the Transvaal Education Department's policy shortly before to concentrate the training of Mathematics teachers in Pretoria under the Department's In-service Training Centre. The result was that no students enrolled for courses in Mathematics, Science or Biology at the beginning of 1973 at the Rand Afrikaans University. However, the University's yearbook does make provision for students without matriculation exemption wishing to take Mathematics in so far as a D symbol (50 %) is laid down as minimum requirement in Mathematics for the School Leaving Certificate (35, p. 305).

c. Mathematics Method Course

The Mathematics Method Course at the Rand Afrikaans University at present provides for the combining of the third-year B.Sc. (Ed.) candidates with the one-year post-graduate candidates because of the small numbers in each group. The Didactics Course in Mathematics is presented by a member of the Faculty of Education. Members of this Faculty also evaluate the criticism lessons when the students are on teaching practice. The syllabus for the various subjects, including Mathematics, follow this broad scheme (35, p. 311):

Subject Didactics

Historical-theoretical viewing of the subject.
The purpose of including the subject in the school curriculum - the formative value.
The choice of topics to realise the goal (in conjunction with primary school).
The study and evaluation of core syllabuses (also differentiated syllabuses of the subject).
Schemes of work.
The application of general didactical principles in the subject.
Methods of teaching the subject (in conjunction with the primary school).
Teaching and learning aids in the subject.
Evaluation: testing and examining in the specific subject.
Typical learning problems and learning deadends in the subject.
Any other aspects which need attention because of the special nature of the subject.

The University spokesman said that he found that the students in his Subject Didactics class, all of whom had already passed at least Mathematics II, had never heard of the Binary system and other topics such as non-Euclidean Geometries now being taught at many of the schools. These topics he gave his students to study at home. The lectures were set aside solely for professional topics such as the study of overseas projects, the History of Mathematics (which he found his students enjoyed very much) and other didactical topics. Extensive use is being made of the video-camera which the university had acquired. Video-tapes are made of actual lessons given by the individual students to the rest of the student class during teaching practice or during mini-teaching lessons and these are discussed afterwards. An ultra-modern Didactical Laboratory is being planned for the new campus in Auckland Park. Form L (see Appendix) is used for evaluating students' criticism lessons.

4.2.11 The University of the Witwatersrand

a. Introduction

In order to qualify for the one-year post-graduate course the prospective Mathematics teacher must have obtained either a B.A. or a B.Sc. with at least two years of Mathematics successfully completed. If the prospective Mathematics teacher has a good matriculation exemption pass, he is allowed to do Mathematics I in his first year. Otherwise he has to take Intermediate Mathematics in his first year and only when he has passed the latter subject is he allowed to take Mathematics I in his second year. The way students are selected for the Intermediate Courses (which apply to all the Science Courses) is as follows: The student's matric symbols are taken and points are awarded for each symbol, 8 points for an A, 7 for a B, 6 for a C and so on. The Mathematics and Science matric symbols are doubled and the cut-off is 42 points, which means that a student who attains 42 points or more may take the proper first-year courses immediately. A student whose total is below 42 must first pass the Intermediate Courses in those subjects he wishes to take in the Science Faculty. For example, a student with the following symbols English C, Afrikaans B, Latin D, Mathematics D, Science E and History D will score the following points: 6, 7, 5, 2 X 5, 2 X 4 and 5 which total 41 points. He will then have to pass the Intermediate Courses in the Faculty of Science before he can do Mathematics I. This student will therefore take four years to obtain his B.Sc. degree provided that he does not fail along the way.

b. Optional Mathematics Courses

A student who has passed Mathematics I can either do Mathematics II which is a highly theoretical course, or he can do Mathe= matics II Ancillary which is a course originally planned for engineering students. Mathematics II Ancillary is a much more practical course than the Mathematics II major course but had the disadvantage that it did not allow a student to go on to Mathematics III. However, to accommodate those students who intended becoming teachers, a Mathematics III (Teachers') course was devised for which Mathematics II Ancillary was acceptable, provided that two courses in Applied Mathematics and Computer Science and one course in Statistics was taken in the degree curriculum.

The syllabus for the Intermediate Mathematics course was not available, but it appears that the lectures are based to a large extent on Serge Lang's book "Basic Mathematics". The syllabuses for the Mathematics courses following on Intermediate Mathematics are as follows (52, p. 248 - 249).

"Department of Mathematics

MATHEMATICS

33101 First Qualifying Course

Axiomatic treatment of the real number system, elementary set theory, indices, polynomials and rational functions, definition of convergent and divergent series, proofs by induction, binomial theorem.

Calculus: Differentiation including partial differentiation, integration including integration by parts. Curve sketching, problems on maxima and minima, areas and volumes.

Coordinate geometry of the straight line, circle and conic sections.

Trigonometry including definitions of the fundamental ratios for all angles, addition theorems, solution of trigonometric equations, and polar coordinates.

Introduction to Vectors, three dimensional geometry, linear dependence and bases, transformations, matrices and determinants.

33104 First Qualifying Course (Special)ϕ

Calculus: Functions, graphs, inverse functions. Differentiation as a rate of change, and the slope of a graph. Elementary rules of differentiation. Integration as the inverse of differen= tiation, and areas as definite integrals. The logarithm and exponential functions from growth problems and integrals; their properties. First order differential equations based on practical problems.

Linear Algebra: Vectors, matrices, eigenvalues, and their ele= mentary properties. Simultaneous linear equations, their relation to matrices and their solution by Gauss reduction.

Elementary Practical Statistics: Elementary probability, bino= mial distribution, normal distribution, elementary hypotheses testing, Chi square distribution, Poisson distribution, corre= lation and regression, one-way analysis of variance, some ele= mentary non-parametric methods.

Elementary Fortran Programming: with exercises illustrating the above material.

(1) Analysis: Sets, functions, countable and uncountable sets. Bounds and cluster points of sets of real numbers. Sequen= ces. Limits of functions of one real variable. Continuity. Fundamental properties of continuous functions. Differen= tiability. Rolle's Theorem and Mean Value Theorems, with applications. Convergence of series. Taylor and MacLaurin series. Introduction to the theory of vector-valued func= tions on n-dimensional Euclidean space.

(2) Algebra: Complex numbers. Finite-dimensional Euclidean vector spaces. Linear transformations and matrices. De= terminants, solution of systems of linear equations. Eigenvalues, eigenvectors and diagonalization of matrices. Elements of classical number theory. Introduction to the theory of groups and other algebraic systems.

(3) Advanced Calculus: Differentiation and differentials. Solu= tions and theory of solutions of ordinary differential equations. Definite integration, multiple integrals, line and surface integrals. Vector calculus. Gauss' and Stokes' theorems.

ϕ Institute of Mathematics course

33204 Second Qualifying Course (Ancillary)*

Limits, continuity and differentiability of functions of one real variable. Rolle's Theorem and Mean Value Thoerem with applications. Convergence of series. Special functions. Partial differentiation, solution of ordinary differential equations.

Complex numbers; real and complex vector spaces, linear trans= formations, linear equations, matrices, canonical forms, eigen= vaules and eigenvectors, scalar and vector products, determinants. Vector analysis. Double integrals.

33301 Third Qualifying Course

Real Variable, including convergence of series, uniform con= vergence of series, uniform continuity, Riemann integration, convergence and uniform convergence of integrals, repeated integrals, and differentiation under integral sign.

Algebra, including matrix theory, linear equations, elementary groups, fields, real numbers, vector spaces, linear transfor= mations and quadratic forms.

Complex variable, including regular functions, Cauchy-Riemann equations, conformal transformation, complex integration. Cauchy's theorem, Laurent's theorem, residues, and examples.

Topology, basic concepts, leading up to the theory of differen= tiable manifolds.

Differential Geometry, including the classical theory of sur= faces, Riemannian geometry.

Special topics (optional in place of Topology), including gamma-function, solution of series of differential equations, Bessel functions, Legendre polynomials, Laplace transforms, partial differential equations, separation of variables, Fourier series, and orthogonal functions.

33305 Third Qualifying Course (Teaching)

The following topics are offered:

Algebraic Fields and Polynomials I: Definitions and elementary

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*The completion of Mathematics II (Ancillary) does not qualify a student for admission to Mathematics III (Major).

properties of rings and fields. The ring of polynomials with coefficients in a field. The division process and the unique factorisation theorem. The field of rational functions with coefficients in a field.

Algebraic Fields and Polynomials II: Vector spaces over an arbitrary field. Extensions of a field; degree of an extension. Transcendental and algebraic extensions. Splitting fields. Algebraically closed fields. Properties of finite fields. Rule- and compass constructions.

Topics in Analysis: Uniform continuity. The Riemann integral. Improper integrals. Uniform convergence. Integration and differentiation of series term by term.

Foundations of Geometry: Axiomatics of Euclidean geometry. Introduction to Non-Euclidean geometry. Plane projective geometry as an axiomatic system. Co-ordinates in the real projective plane. Transformation groups and Klein's 'Erlanger Programm'. Projective geometry as the study of properties invariant under the group of collineations. Affine and Euclidean geometries as subgeometries of projective geometry.

Topics in Finite Mathematics: (1) Permutation groups. The counting theorems of Burnside and Polya, with applications. (2) Partially ordered sets and lattices. Complete lattices. Distributive lattices. Modular lattices. Complemented lattices. Boolean algebras, defined as complemented distributive lattices. Applications to the algebra of subsets of a set, to propositional calculus, and to switching theory and circuit design. (3) Elements of the theory of graphs. Existence of Euler and Hamiltonian paths. Properties of planar graphs. Colouring a graph; the four-colour problem.

Sets and Numbers: Well-ordered sets and ordinal numbers. Successor and limit ordinals, the natural numbers. The Contor-Bernstein theorem and the well-ordering theorem. Cardinal numbers.
The continuum hypotheses.
The construction of the integers and rational numbers from the natural numbers. The real numbers as Dedekind cuts in the set of rational numbers. Completeness of the set of real numbers. Decimal representation of real numbers.

History of Mathematics: A survey of the history of mathematics, with special emphasis, firstly, on the development of those branches of mathematics of particular interest to schoolteachers, and secondly on mathematics as a living part of human culture."

(i) The four year non-degree course

As far as could be ascertained very few, if any, students were following this course, firstly because no non-matriculation exemption students were admitted to the University and secondly because the course was only in its second year so that the students themselves were still trying for the degree course first before deciding finally. The Yearbook of the University of the Witwatersrand, however, makes provision for four special Mathematics courses for prospective teachers, one in each year of the diploma course. The syllabuses are as follows (52, p. 668):

"Mathematics. First qualifying course

Axiomatic treatment of the real number system, elementary set theory, polynomial and rational functions, binomial theorem, induction. Differentiation, the integral, curve sketching, maxima and minima, areas and volumes. Trigonometry, solutions of trigonometric equations, polar co-ordinates.

Second qualifying course

Partial differentiation, integration techniques. Series. Vectors and applications. Matrices and Determinants. Complex numbers.

Third qualifying course

Differential equations. Volumes and surface areas of solids. Sets, countable and uncountable - bounds, cluster points, sequences. Cauchy's Convergence Theorem. Continuous functions, differentiability, Rolle's Theorem. Mean Value Theorem, Taylor and MacLaurin expansions. Convergence tests. Complex numbers and applications. Finite dimension Euclidean vector spaces. Linear transformations, matrices and matrix operations.

Fourth qualifying course

Functions of two variables. Power series, uniform convergence and further convergence tests. Riemann integral convergence. Matrices-rank, inverse, solutions of sets of linear equations, eigenvalues, orthogonal and Hermitian matrices. Elements of classical Number Theory. Introduction to theory of groups."

It will be noticed that the above four courses, although not given very fully, correspond closely to the Transvaal Education Department's four courses in Academic Mathematics (see paragraph 3.2.3).

c. Mathematics Method Courses

As far as the Method of Mathematics teaching is concerned, it is of interest to note that at the University of the Witwaters=rand the Faculty of Education does not present the Methods courses as is the case at the Universities of Pretoria and Potchefstroom for example. The Methodology is done by members of the academic departments so that the Methods Course in Mathematics is done by members of the Mathematics department Similarly, criticism lessons are evaluated by members of the Mathematics department and not by members of the Education Department. The viewpoint of the University of the Witwatersrand is that a Mathematics teacher (and any other teacher) must be a mathematician first and foremost and then only a teacher as such.

As far as the Methodology of Mathematics for the four-year non-degree diploma is concerned, the University of the Witwatersrand offers the following course (52, p. 658):

"Mathematics - Methodology

Study of the Mathematics taught in schools overseas.
Comparisons with South African syllabuses.
Objectives, evaluation and assessment.
Educational Technology - applications in the teaching of mathe=matics.
Topics from the History of Mathematics with particular emphasis on those covered by the school syllabuses.
The Mathematics suitable for

(a) the weak pupil
(b) the gifted pupil.

Mathematics teachers' journals and relevant literature."

Presumably this course will be presented to prospective teachers in their fourth year of study as from 1975 when the first group of teachers will be in its fourth year of study. As is the case with the one-year post-graduate diploma, this Methodology Course will be presented by lecturers of the Mathematics depart=ment and not by lecturers of the Education Faculty. The same arrangement will also apply when criticism lessons are evaluated. Micro-teaching is not practised at the University yet, but is being planned for.

4.2.12 Further and In-service Training

In-service and further training is an aspect of teacher training for which special provision was made in the Education Policy Amendment Act. Whereas the provinces are not allowed to train secondary school teachers, not even in conjunction with the universities, further and in-service training of secondary school teachers was not taken away from the provinces (National Education Policy Amendment Act, No. 92 of 1974, section 1A(2)). No details of the new arrangements as regards in-service and further training for primary or secondary school teachers are available for the Education Departments of Natal, the Cape Province or the Orange Free State, but recent information obtained from the University of South Africa has thrown light on the direction in which this aspect of teacher training is being planned in the Transvaal.

A teachers' training college for in-service and further training has been established in Pretoria. It started functioning as from 1 January 1974 and enrolled its first students in July 1974. This College is to work closely with the University of South Africa: Syllabus Committees, for instance, will be constituted on a fifty-fifty basis for the approval and setting of syllabuses. Three main types of training are envisaged:

1. Training which is meant for students (practising teachers) who wish to further their studies, as for example, a teacher with Mathematics I who wishes to enrol for Mathematics II for degree purposes. In such a case the course will be the usual pure Mathematics II course as offered by UNISA for degree purposes.

2. Training which will be the joint responsibility of the provincial in-service training college and UNISA. The courses which will be offered will cater mainly for practising teachers who have professional teaching qualifi= cations only and who wish to better their qualifications. So, for instance, practising teachers with a three-year Teacher's Education Diploma can obtain the four-year higher Education Diploma (Secondary School) by passing the following subjects (in the case of a teacher wishing to specialise in Mathematics): Pedagogics 3rd and 4th year, Mathematics 1st, 2nd, 3rd and 4th year, Chemistry 1st and 2nd year and Physics 1st and 2nd year. In the case of a teacher with

Mathematics I at university level to his credit, exemption for Mathematics 1st and 2nd year (College) may be given, but thereafter no further exemption is considered because the 3rd and 4th year courses at college level are integrated content and method courses. The University of South Africa will help in the examining, moderating of examination papers and generally taking responsibility for the standard of the courses. Although the courses will be arranged on a correspondence basis, lectures and vacation schools are to form an important aspect of the courses.

3. The third type of training to be undertaken by this College will involve primary school teachers. As this aspect of teacher training is more specifically the domain of the provincial education departments, the University of South Africa's rôle will be more of an advisory one. Provision is made for two main types of further training: For teachers with the two-year Teacher's Lower Education Diploma to obtain the three-year Teacher's Education Diploma (TED), and those with the three-year TED to obtain the four-year Higher Education Diploma (HED) (Primary or Secondary school orientated). A teacher who wishes to obtain the HED (Primary school orientated course), for instance, must take Pedagogics 3rd and 4th year, Afrikaans 1st and 2nd year <u>or</u> English 1st and 2nd year <u>or</u> Elementary Mathematics 1st and 2nd year, and two other school subjects on 1st and 2nd year college level.

It must be emphasised that the position as regards further train=ing described above applies to the Transvaal Education Depart=ment only. Details as to the actual organization of in-service "refresher" courses are not known. It is also not known what arrangements the other provinces are contemplating in respect of further and in-service training. The advantage of arranging the further and/or in-service training under the auspices of the University of South Africa (UNISA) is that the excellent (correspondence) facilities which UNISA has specifically for correspondence courses are then also available for these teacher's training courses.

As has already been stated, the College for Further Training in Pretoria expected to welcome its first students in July 1974. Syllabuses are in the process of being <u>finalised</u>. In the case of those subjects in which the shortage of teachers is acute of which Mathematics is one, syllabuses are already available as the Transvaal Education Department has been providing its teachers with opportunities of furthering their studies in these "scarce subjects" for the past few years. The syllabuses for these subjects had previously been ratified by a panel of university lecturers and are therefore now available for UNISA's consideration. The Mathematics syllabus, for the four-year Higher Education Diploma which will most probably form the basis of the finalised Mathematics syllabus up to second-year Univer= sity level, as suggested by the Transvaal Education Department, is as follows:

MATHEMATICS A (Spread over 18 months)

1. Properties of real numbers (not in depth), set theory, moduli, inequalities, induction, the binomial theorem.

2. Functions and relations.

3. Trigonometry.

4. Limits and continuity.

5. Derivatives of polynomials and elementary applications.

6. Specific integrals and applications (polynomials, volumes of revolution etc.).

7. Further differentiation and integration (the chain rule, trigonometric functions and inverses).

8. Exponential and logarithmic functions. Further differentia= tion and integration (partial fractions, length of a curve, areas and volumes of revolution etc.).

9. Partial integration.

10. Taylor's theorem for one unknown (maxima and minima).

11. Functions of more unknowns, partial differentiation.

12. Complex numbers.

MATHEMATICS B (Spread over 18 months)

1. Linear equations.

2. Vector spaces (R^2, R^3, – – –, R^n) with applications in Geometry and Analytic Geometry.

3. Homomorphisms, matrices and determinants.

4. Groups, rings and fields.

The above syllabus has been agreed on by both the Transvaal Education Department and the University of South Africa and was based on the syllabus which the first-mentioned had drawn up previously and which had been accepted as of second-year university standard. Because this is the first Mathematics syllabus drawn up specifically for secondary school teachers and which was accepted to be of second-year university standard, the syllabus is given in full for future reference. It must be emphasised though that this syllabus will not necessarily remain unchanged once the In-service Training Programme is finalised. The syllabus, which unfortunately was only available in Afrikaans, is reproduced in the Appendix (see Appendix A, page 287).

4.2.13 The Colleges for Advanced Technical Education

The above colleges, which fall directly under the jurisdiction of the Department of National Education, have in the past also issued teaching diplomas. These diplomas, known as the National Teacher's Diplomas could be gained in one of the following directions of specialization: Commerce, Home Economics, Workshop and Technical. In this study on the training of Mathe= matics teachers it is only the Technical endorsement which is of interest. The National Teacher's Diploma (Technical) is a one-year full-time course (two years part-time) and must be regarded as being along the same lines as the one-year post-graduate courses offered by the universities (and the provincial colleges of education before 1969).

The minimum admission requirements for the NTD (Technical) course is one or more of the following: A Bachelor's degree in Engineering, a Bachelor's degree in Pure Science, a Bachelor's degree in Applied Science, a National Diploma (with both official languages in the Senior Grade) or a recognised equivalent of any of the above. National Diplomas include such diplomas as the Engineering Diploma, Production Engineering Diploma as well as the Technican Diplomas. However, each of the above mini= mum qualifications for the National Diplomas must include at least two subjects which are taught in technical high schools, apprentice schools or the technical departments of technical colleges. In practice it very seldom occurs that persons with the above-mentioned degrees enrol for the National Teacher's Diploma (Technical). The course is invariably taken by journeymen who have studied further to gain a National Techni= cian's Diploma. Many of them may have been teaching the appren= tices in the workshops and by chance may have been asked to take a junior Mathematics class. Because of the shortage of teachers, especially in Mathematics, they finally ended up teaching Mathe= matics on a full-time basis. In order to ensure that they are eligible for promotion in this new direction they enrol for the National Teacher's Diploma (Technical) and do the Method of Mathematics Course.

In order to be able to enrol for the Method of Mathematics Course these men must be recommended by the principal of the Technical High School or College, whatever the case may be. This was thought necessary to ensure that the men enrolling for the course had a sound background in Mathematics. As they mostly had only the National Technician's Certificate Mathematics to their credit (N.T.C. V), which was not considered on a par with any of the university Mathematics courses, trouble was taken to ensure that these men had passed Mathematics with fairly high marks and were making a success of their teaching of the subject. The numbers qualifying as Mathematics teachers were small. In 1974 eighty two men enrolled for the National Teacher's Diploma (Technical) of whom no more than twenty took the Method of Mathematics Course. These figures represent the total number of entrants in the RSA, the main training centres being the Colleges for Advanced Education in Cape Town, Johannesburg and Pretoria. The curriculum for the diploma is as follows (11, p. 10):

"Group I: Examination Subjects:

Educational Psychology.
History of Education.
Educational Principles and Teaching Methods.
Practical Teaching and Blackboard Work.
School Hygiene and First Aid.
Afrikaans (written and oral).
English (written and oral).
The Method of <u>Two</u> of the following:

(i) Mathematics
(ii) Science
(iii) Technical Drawing
(iv) Technical Subjects
(v) Trade Instruction

Group II - Credit subjects:

Religious Instruction
Physical Education

Group III - Non-examination subjects:

Singing and Appreciation of Music
Drama and Speech Training."

Full-time student teachers must do practice teaching for a period of three weeks at least twice a year at technical high or apprentice schools or technical colleges. Part-time and correspondence students must submit proof that they have com=pleted at least 100 hours recognised full-time or part-time teaching.

The Mathematics Method Course prescribed for the National Teacher's Diploma is as follows (11, p. 23):

METHOD: MATHEMATICS

(3-hour paper)

The following general principles ought to be established:-

1. Why do we teach mathematics?

(a) Mathematics is more than a commercial necessity - it is the handmaid of practical science - it helps us to under=stand the world and life. It is an essential for an understanding of the obligations and privileges of intel=ligent citizenship.

(b) Mathematics demands the power to reason and to concentrate. It offers an inexhaustible field of simple exercises in logic. It develops the use if imagery. It tends to calm=ness, confidence and a uniform emotional disposition.

(c) Mathematics is not static. It is progressive and vital and must be taught that way. Nevertheless, where-ever possible, mathematics should be approached from its historical aspect.

(d) Mathematics should teach a student to "look behind" figures, to find their meaning and to enquire whether it is valid or important. He should neither be overawed by figures nor deceived by them.

(e) Science is transformed from being merely a descriptive and qualitative system into a much more powerful and beautiful system when it becomes quantitative and mathe=matical.

(f) Satisfactory teaching of Mathematics should lead to logical thought and precise statement. Every teacher is a language teacher.

(g) In all mathematics teaching stress should be laid on rough estimates and methods of checking results.

(h) Systems of setting down and working out problems should be taught that allow both the argument and the mathematical calculation to be checked at each stage.

(i) Mathematics is to be regarded not so much as a philosophic speculation as a practical instrument.

2. Clear, consistent expression - frequent repitition - correct use of terms.

3. Make sure of giving the experience first - abstractions can come much later.

4. Mathematical reasoning (1) analysis, (2) synthesis i.e. proceeding from concrete to abstract.

5. Continual attention to accuracy is essential.

6. Rules of thumb may be given - not necessarily wrong to do so - it is of much more importance to explain processes. Probably only a limited number of pupils will remember the reasoning but it must be given to develop understanding.

7. Mathematics laboratories - for practical work in geometry, mensuration, surveying, mechanics etc. (Vernier, micro= meter screw gauge, slide rule ....)

8. Arithmetic, Geometry, Algebra - not to be treated as sepa= rate subjects. Must be fused together.

9. Keep in close contact with practical, everyday life - use price lists, P.O. guides, almanacs etc., as sources of examples.

The following points may be used to illustrate the above but are to be regarded only as a random selection of topics:-

Arithmetic

(i) The need to analyse every general operation in order to provide -

(a) adequate teaching of each difficulty;

(b) grading of difficulties.

Teach ONE thing at a time.

(ii) The need for drill - plenty of oral work - knowledge of tables essential.

(iii) Importance of wall charts.

(iv) Use of diagrams i.e. in teaching of vulgar fractions.

Specimen lessons should be drawn up on some of the following, and criticism lessons:-

The four rules (numbers and money); the metric system; factors and multiples; tests of divisbility; primes and composite numbers; simple indices; H.C.F. & L.C.M.; signs; symbols; brackets; first notions of equations; vulgar and decimal fractions; powers; roots; ABC of logarithms; ratio and proportion.

Commercial Arithmetic - %, simple interest, compound interest, rates and taxes.

Mensuration, simple formulae, papering of rooms, carpeting of floors, rectangular solids.

Algebra

Criticism lessons and specimen lessons on some of the following topics.

Signs as direction posts: addition and substraction, multipli= cation and division, algebra and arithmetic in parallel, geome= trical illustrations, graphs - from the column graph to the locus.

y=mx + c-direct proportion, linear equation circle;
xy=k-inverse proportion Boyle's Law; Parabolic Functions.
Turning point. Maximum and minimum. Log curve. Simultaneous equations. Algebraic manipulation-factors. Algebraic phraseology; notation. Detached coefficients. Remainder and Factor Theorems. Algebraic equations. Cyclic expressions.

Geometry

Specimen lessons and criticism lessons on some of the following topics:–
Early work – Planes and perpendiculars; solids and surfaces; angles; surveyors – their work, symmetry; congruency, simi= larity; classifying and defining.

Working tools for future deductive treatment – Angles at a point; parallels; similarity; Pythagoras; circles.

Early deductive treatment – Proportion and similarity; circles and polygons; principle of duality, geometrical riders and their analysis.

Plane Trigonometry

Specimen lessons and criticism lessons on some of the following topics:–

Tangent–problems; sine–problems, cosine–problems; simple inter–relations; reciprocals; ratios of common angles; simple identities; obtuse angles; the general triangle; angles up to 360°; compound angles.

Calculus

Slope; limits; rate; rate functions; rate as a slope; notation."

The student teachers who gained the National Teacher's Diploma (Technical) and so qualified as Mathematics teachers mostly remained at the technical high schools and seldom found their way into the provincial schools. These teachers however, have always been considered the pick of the crop as far as the technical schools and colleges were concerned. What appears to have been a serious problem, however, was the number of men teaching Mathematics at the technical high schools who had not undergone any professional teacher training such as the above diploma course and whose Mathematics qualifications were such that headmasters could not recommend them for the above Mathe= matics Method Course.

Since 1969, however, the technical high schools have been taken from the Department of National Education and entrusted to the provincial departments of education. With the National Educa= tion Policy Amendment Act of 1969 (Act no. 73 of 1969) stipulating that all secondary school teachers are to be trained by the universities as from 1967, the National Teacher's Diplomas offered by the Colleges for Advanced Education are being phased out, most of them experiencing their final year in 1974.

The University of Cape Town has already made provision for the training of teachers for the technical high schools with the introduction of a full-time one-year diploma course as from 1975. The course is to be known as the Secondary Teacher's Diploma (Technical). The entrance qualifications are the same as for the National Teacher's Diploma (Technical), except that the University of Cape Town insists on entrants having the new Higher National Diploma for Technicians (4-year course) or the National Diploma for Technicians (3-year course) which replace the old N.T.C. IV and N.T.C. V certificates and are of a higher standard. The Mathematics Method Course student teachers en= rolling for this diploma and who wish to specialise in Mathe= matics are expected to take the same course as that offered to post-graduate student teachers, namely Course CS 10-Method of Mathematics. Similarly the Rand Afrikaans University has also decided to offer a one-year higher education diploma (technical) known as the Nagraadse Hoër Onderwysdiploma (Tegnies). The minimum entrance requirements will be a Bachelor's degree, or the National Diploma for Technicians. For the rest this one-year course is exactly the same as that followed by other post-graduate student teachers except that the methods courses of technical subjects are offered.

RAU offers a second diploma for technical student teachers, namely the Hoër Onderwysdiploma (Tegnies) which is open to National Diploma for Technicians candidates as well as the old N.T.C. III certificate holders, provided that they have a further three-year technical qualification which includes at least two school subjects (technical subjects). This is also a one-year diploma course and candidates are expected to com= plete at least six weeks of teaching practice at approved schools.

4.3 CONCLUSION

From the preceding chapter it becomes clear that one aspect of secondary teacher training at the universities has given rise to many problems. Whereas the one-year post-graduate teaching diploma and, when they have been introduced, the four-year combined academic-professional degree are on a sound footing, the four-year non-degree secondary teacher's diploma students are finding it difficult to hold their own in the science sub= jects. Whereas a student with a School Leaving Certificate can still manage the Human Sciences (Arts) subjects at university, the Natural Science subjects, such as Mathematics I, are in most cases too difficult for him. Two of the universities have decided that it is futile to try and cater for students without a Matriculation Exemption certificate without lowering the standard of their courses. With one exception all the other universities allow students without a Matriculation Exemption certificate to attempt the Mathematics I, the standard first-year degree course. With a few exceptions these students simply fail. The result is that there is a swing to the Human Sciences (Arts) subjects with disasterous consequences for the future of Mathematics at school. The students with degrees in Mathematics who take up teaching ultimately are very few indeed.

As far as could be ascertained the following are the numbers of students taking Mathematics I who are enrolled for the four-year non-degree secondary teacher's diploma: There are two students at the University of Natal, eleven at the University of Pretoria and one at the University of Port Elizabeth, thus a total of fourteen students. The other universities either do not have the four-year non-degree secondary teacher's diploma or their students simply keep clear of Mathematics. At the Potchefstroom University for Christian Higher Education thirty-one students are doing the special Mathematics course for school teachers which is not recognised for degree purposes. As far as the graduates are concerned the position is somewhat better. The following table shows the stance of prospective Mathematics teachers at the universities.

Whereas the position as regards the training of primary school teachers is not completely unsatisfactory the same cannot be said of the training of secondary school teachers in the light of the above. Before recommendations are offered in an attempt to bring about an improvement in the situation, it is advisable to consider the position of teacher training in some Western countries.

TABLE 4.4

THE NUMBER OF FINAL YEAR STUDENT TEACHERS WITH AT LEAST MATHE=MATICS I AND THE NUMBER OF STUDENTS ENROLLED FOR THE FOUR-YEAR NON-DEGREE DIPLOMA AT PRESENT TAKING MATHEMATICS AT UNIVERSITY

University	Final year de=gree students with at least Mathematics I 1974	Students enrolled for the four-year non-de=gree secondary teacher's diploma taking Mathe=matics at university 1974	Total
Cape Town	19 (10 with Maths 1 only)	-	19
Natal	24	2	26
OVS	6	-	6
Potchefstroom	5	31*	36
Pretoria	22	11	33
RAU	4	-	4
Witwatersrand	3	-	3
Port Elizabeth	10	1	11
Rhodes	7	-	7
Stellenbosch	(Still being awaited)		
TOTAL	100	45	145

* Special Teacher's Course in Mathematics.

CHAPTER 5

THE TRAINING OF MATHEMATICS TEACHERS IN SOME WESTERN COUNTRIES

5.1 THE UNITED STATES OF AMERICA

5.1.1 Introduction

It is a particularly difficult task to give an overall picture of teacher training in the United States of America as no two states have similar requirements for the certification of teachers and therefore similar teacher training programmes. Apart from this, profound differences in teacher training courses often exist between teacher training institutions within the same state.

5.1.2 The training of primary school Mathematics teachers

In the United States of America primary school teachers are trained at universities offering primary school teacher training orat colleges of education. The colleges of education are also permitted to award degrees, however, with the result that in 1971 a survey revealed that 71 per cent of all primary school teachers were in possession of a bachelor's degree and 20,5 per cent in possession of a master's degree in education (27, p. 285).

Over and above the school leaving certificate no other admission requirements are demanded of prospective primary school teachers on enrollment at the above-mentioned institutions. It is there= fore possible to enrol for a bachelor's degree in primary education with nothing more than an introductory course in Mathematics. Mathematics or any form of Elementary Mathematics has only recently been made compulsory in many states. The teacher training course for primary school teachers in the state of Maryland, for example, is as follows (58, p. 69):

"<u>Bachelor's degree in primary school education</u>

A. Academic requirements

1.	English	12 semester hours*
2.	Social Studies	15 semester hours
3.	Science	12 semester hours
4.	Mathematics	6 semester hours
5.	Music	2 semester hours
6.	Art	2 semester hours
7.	Physical Education	2 semester hours

B. Professional requirements

1.	Social, historical and philosophical aspects of education	3 semester hours
2.	Psychological aspects of education	3 semester hours
3.	Curriculum, method	12 semester hours
4.	Teaching practice and observation	8 semester hours"

* A unit of 12 semester hours for instance could mean a course for which students meet 4 times a week for the duration of 3 semesters or 6 times a week for the duration of 2 semesters or 12 times a week for the duration of 1 semester. There are two semesters in an academic year and 120 semester hours are usually spread over 4 years.

With this bachelor's degree a teacher may teach up to grade 6 in a primary school. As a result of recommendations made by the Committee on the Undergraduate Programme in Mathematics (CUPM) in 1966, the training of primary school Mathematics teachers has improved. Whereas there were 22,7 per cent of the teachers' training colleges in the United States of America in 1962 which did not require any Mathematics for their Elementary Education Majors, the percentage was only 8,3 in 1966. It can therefore be seen that the importance of teaching Elementary Mathematics is being realised to an increasing extent in the United States of America. The content of the Mathematics courses for prospective primary school teachers has been characterised as being based on "an elementary-secondary mathematics background of traditional mathematics" (29, p. 298): The syllabuses cover topics such as number systems and set theory while the algebra and geometry syllabuses are mainly a repetition of the secondary school syllabuses.

5.1.3 The training of secondary school Mathematics teachers

a. Academic training

As far as the training of secondary school teachers is concerned, it can once again be stated that the academic standards and the content of the courses differ widely, not only from state to state, but also from university to university. However, the tendency in most states is to raise the requirements for qualification as secondary school teachers. Where the duration of the training has always been four years, many states are beginning to demand five years of training for certification. In New York State and in California five years of training for secondary teachers has already been instituted (8, p. 46). The vast majority of teacher training institutions, however, offer four-year training courses which in general follow the undermentioned pattern for a student who wishes to become a Mathematics teacher (8, p. 174):

"Bachelor's degree in secondary school education

1.	General Education, including 6 hours of Mathematics, 12 hours of Science, and 3 hours of General Psychology	60 semester hours
2.	Educational Psychology	3 semester hours
3.	Philosophy or History or Sociology of Education	3 semester hours
4.	Physics or Chemistry	6 semester hours
5.	Field of concentration (Mathematics)	39 semester hours
6.	Practice Teaching and Special Methods	9 semester hours
	Total	120 semester hours"

Such a teacher training programme is spread over four years and on its successful completion a student receives a bachelor's degree. Most institutions require 120 semester hours spread over four years for a bachelor's degree where a unit of 3 semester hours, for instance, denotes a course for which students meet three times a week for the duration of one semester.

CUPM recommended in 1961 and in 1965 the following minimum requirements as regards the content of the Mathematics courses for the training of secondary school teachers (recommendations which are highly respected by the teacher training institutions in the United States) (29, p. 290): Three courses in Elementary Analysis (which includes Analytical Geometry), one year of Calculus, two courses in Abstract Algebra (which includes Linear Algebra and Groups, Rings and Fields), two courses in Geometry with Advanced Analytical Geometry which is aimed more at acquiring insight into School Geometry, two courses in Probability Theory and Statistics and one course in Computer Science. Courses such as Applied Mathematics, Number Theory, the History of Mathematics and Topology are also highly recommen= ded by CUPM. The two courses in Geometry aim at gaining insight into the basics of Euclidean Geometry, that is, the traditional approach, but also into the basics of non-Euclidean Geometry.

The following table gives an indication of the qualifications Mathematics teachers possess in the United States of America (27, p. 286):

"TABLE 5.1

THE HIGHEST QUALIFICATIONS OF ALL SECONDARY SCHOOL MATHEMATICS TEACHERS IN 1961 AND 1970

Year	No de= gree	2 year diploma	Bachelor's degree	Master's degree	Doctor's degree	Total
1961	0,3 %	1,2 %	60,2 %	38,1 %	0,2 %	100 %
1970	0,7 %	0,5 %	59,2 %	37,2 %	0,3 %	100 % "

The high percentage of teachers with a master's degree is re= markable but apparently a bachelor's degree with Mathematics as major is not regarded as sufficient to teach Mathematics to the higher grades, grades 9 to 12, at the secondary school level (29, p. 285 and p. 302). Many teachers therefore enrol for a further programme of study to gain a master's degree. A typical programme for a master's degree is that of Harvard University which starts with a seven week long summer session during which teaching is done under supervision in the mornings and planning and evalu= ation in the afternoons. Lectures are attended and the curriculum is as follows (29, p. 304):

"Introduction to Education	6 semester hours
Educational Psychology	3 semester hours
Mathematics courses	6 semester hours
Curriculum and method in Mathematics	6 semester hours
Course in Anthropology, History, Philosophy or Sociology	3 semester hours
Elective	3 semester hours
	27 semester hours"

This programme includes a year of internship for which 9 semester hours are earned. The above course is usually taken by a teacher who is already in possession of a bachelor's degree with Mathematics as major, but who did not do an education-orientated bachelor's degree. The course is therefore comparable to the one-year post-graduate professional diploma course for graduate teachers in the Republic of South Africa. At any rate, if a teacher passes the above course at Harvard he is awarded a Master of Arts in Teaching degree (MAT-degree) (29, p. 304). If a teacher did acquire an education-orientated bachelor's degree, his course for the MAT-degree is the same as that described above although fewer education courses are required (29, p. 305). As regards the content of the Mathematics courses, variations are to be found from university to university. Yeshiva University's course for the MAT-degree, for instance, concentrates on Mathematics and offers little Education with it, while the University of Washington's course consists mainly of Education and offers little additional Mathematics in its MAT-degree (29, p. 305).

b. <u>Professional training</u>

Although most of the professional training aspects have already been mentioned (because of the fact that the teacher training courses in the USA are invariably integrated academic-pro= fessional courses), mention must be made of the great number of research projects undertaken in the field of education. Almost every university seems to be working on some or other project aimed at replacing the traditional teacher training programmes with something more dynamic. A feature of these projects is the great emphasis which is placed on teaching practice. Mere class-room observation is considered a waste of time. Indiana State University, for instance, conducted a very successful experiment in which their final year teaching students were placed in surrounding schools on a full-time basis. Seminars were held at the schools under the guidance of the lecturers at which the students and the teachers with whom they were placed participated (18, p. 340). The University of New York arranged a similar experiment while the University of Illinois conducted another very interesting experiment that is well-known everywhere today, namely, mini-teaching (18, p. 341). A class is divided into groups of four to six pupils and to each group two or three students are assigned. The students are responsible for the progress of their respective groups and must ensure that the syllabus is covered. In addition the class-teacher keeps an eye on the activities and problems the students have encountered are discussed afterwards.

Class observation by the student is generally disapproved of in the experiments since it is felt that it is an impossible task for an inexperienced student to pick out aspects of the lesson which are important and to realise the importance of these aspects for the progress of the whole lesson. Class observation can therefore only be of use if it is well controlled, that is, where a lecturer and other students are also present in order to discuss the lesson afterwards. But with so many outsiders present lessons often become unnatural, defeating the purpose of the class-room observation.

Taking all these experiments into account, it is to be expected that the theoretical side of teaching would receive as much attention as the practical. This is not so, however. There is little sign of any subject didactics in Mathematics or in any other subject. Aspects such as the aims of Mathematics teaching, selection of subject content and its arrangement according to the aims do not seem to be considered. American teacher training institutions appear to believe that the best training for aspirant teachers is to be gained in the practical situation and no stone is left unturned to ensure that this practical side of the aspirant teachers' training takes place as efficiently as possible. They believe that without this prac=tical training too sudden a change occurs from student life to the responsibility of a class-room teacher which simply results in survival methods of teaching.

This is not to say, however, that no methods courses are offered. In the revised edition of the CUPM report, Recommendations for the Training of Teachers (December 1966), the following methods course for Mathematics is recommended (29, p. 297):

"1. The objectives and content of the many proposals for change in our curriculum and texts.

2. The techniques, relative merits, and roles of such teaching procedures as the inductive and deductive approach to new ideas.

3. The literature of mathematics and its teaching.

4. The underlying ideas of elementary mathematics and the manner in which they may provide a rational basis for teaching.

5. The chief applications which have given rise to various mathematical subjects."

As has already been mentioned, the CUPM report carried great influence so that the above curriculum can be considered representative of the Mathematics Methods courses to be found in the United States of America.

c. In-service training

In-service training in the United States of America is left to the initiative of the teacher. Broadly speaking, two types of in-service training are to be found. In the first place in-service training is found at universities and colleges which organise courses that can be taken during the afternoons and evenings during the week and on Saturday mornings. This type of training is very popular because each further qualification results in an increase in salary. Unfortunately the increase in salary often does not depend on the nature of the courses taken but simply on the number of semester hours, namely 30, that must be gained as credits. The result is that often the easiest and most unusual courses that have little to do with teaching are taken to achieve the 30 semester hours credit (8, p. 192).

In the second place Summer Schools are arranged which teachers may attend to improve their qualifications. These Summer Schools take place during the summer school vacations and on an average, last five weeks. Their courses are concentrated and usually of a high standard. Lectures are attended on weekdays and lecture tours are often arranged. Once again teachers seem to shy away from furthering their studies in their teaching subjects, as for example, Mathematics. The tendency is to acquire qualifications in administration and guidance, probably because these subjects ensure promotion to fields out of the class-room (8, p. 193).

5.2 THE TRAINING OF MATHEMATICS TEACHERS IN ENGLAND AND WALES

5.2.1 Introduction

Teacher training in England and Wales is undertaken mainly by teacher training colleges which cater for both primary and secondary school teachers. A person wishing to enrol for any of the teacher training courses available must be at least 18 years old and have passed at least five subjects on the "ordinary level" of the General Certificate of Education examinations. At present, however, about 63 per cent of the students enrolling for the teacher training courses have passed one or more subjects on the "advanced level", which is "...... comparable ...... to the sophomore (i.e. 2nd) year of a good American college" (38, p. 23).

In contrast to the USA, where each college and university is an autonomous institution, only the universities in England and Wales are autonomous while the teacher training colleges are grouped under the various universities. Each university therefore has under supervision of its University Institute of Education several teachers' training colleges. The University of London's Institute of Education, for example, has two departments of education with 34 teachers' training colleges, while the University of Manchester's Institute of Education has two departments of education with nine colleges (59, p. 137). These Institutes with their university departments and training colleges are controlled by a Board on which the university, the colleges, the local education authorities and the teachers' associations are represented. This Board functions completely autonomously. Particularly significant is the fact that every lecturer in an Institute's education faculty is a member of a subject committee. All the Mathematics lecturers at the universities and colleges which form part of an Institute therefore meet regularly to determine the content of the courses and to guard against a drop in the standard. There is no national body controlling these Institutes but the Institutes do keep in close contact with one another (59, p. 139).

5.2.2 The training of primary school Mathematics teachers

The duration of the primary school teachers' training courses in England and Wales is three years and three main streams are recognisable in the courses, namely:

a. A professional stream which concentrates on the theory and practice of teaching and which includes about 15 weeks of teaching practice spread over the three years;

b. academic training which allows the prospective primary teacher to specialise in one or two main subjects, and

c. curriculum courses concentrating on the methodology of teaching.

An aspect of the primary teachers' training course that is unique is the fact that a student can specialise in a subject of his choice (a subject such as Physics or French for example) although he cannot ever teach it in the primary school. This forms part of the English belief that any study done in depth contributes to the usefulness of the person seeing that he is then an "educated" person. Students have to take certain compulsory subjects as well, such as English and Elementary Mathematics which is considered important subjects (59, p. 144).

5.2.3 The training of secondary school Mathematics teachers

In order to qualify as a secondary school teacher in England and Wales a student has two options:

a. He can go to university and acquire a bachelor's degree in almost any field of study he wishes and then complete a one-year post-graduate teacher's diploma at the university's education department, or

b. he can enrol for a secondary teacher's diploma at a teachers' training college (23, p. 1).

As far as the first possibility is concerned, only a small minority of students follow this course, especially because the universities demand extremely high entrance requirements. The students who do qualify along these lines, however, are snapped up by the old traditional Grammar Schools. The Mathematics courses which these students take at university differ in no way from the Mathematics courses taken by students doing any other degree: No specific provision is made for a more school-orien= tated Mathematics course for prospective Mathematics teachers.

During the fourth post-graduate year of study the following aspects are covered:

(a) Educational Theory which includes subjects like Psychology, Sociology, Philosophy and History of Education.

(b) The study of the main subject or subjects which the student intends teaching at secondary school but with consideration of the school situation.

(c) Teaching practice of about twelve weeks.

As regards the second possibility, namely that of attending a teachers' training college for a secondary school teacher's diploma significant developments are taking place. A report tabled by Lord James of Rusholme in 1972 especially recommended many important changes in the training of secondary school teachers. It is envisaged that the training of secondary school teachers should be spread over four years instead of the present three and that the new four-year course should be known as the Bachelor of Education (B.Ed.) course. The colleges have to work in close co-operation with the universities in offering this B.Ed., but this presents no problem seeing that the colleges have always been closely associated with the universities through the universities' Institutes of Education as has already been mentioned. As far as salary recognition is concerned, it is proposed that the B.Ed. degree should be considered on a par with any other degree obtained at a university (23, p. 2).

a. Academic training

Since each university's Institute of Education is completely autonomous, some of them have already implemented the main re= commendations of the James Report in the belief that their ratification is a mere matter of formality. Durham University, for example, has already instituted its B.Ed. degree along the lines proposed by the James Report for the 1972 academic year. This B.Ed. degree is spread over four years and has two main aspects namely, a mainly academic side which is covered during the first two years and a mainly professional side which covers the final two years. Mathematics is an optional subject. At the end of the first two years' academic course an examination is written and if successful a student receives a Teacher's Certificate. Students must pass this examination before being allowed to proceed with the final two years of the B.Ed. degree. The syllabus for the first two years is as follows (14, p. 636):

"a. Theory and practice of teaching;
b. other professional courses, and
c. a main subject (e.g. Mathematics)."

Once a student has successfully completed the first two years he is admitted to the third year in which the following courses are taken:

"a. Education, which includes subjects such as Philosophy of Education, Psychology of Education and Sociology of Edu= cation;

b. advanced courses in the main subject (e.g. Mathematics), and

c. a second subject which compliments the main subject (a student with Mathematics as main subject has to take Applied Mathematics)."

At the end of the third year another examination, the Qualifying examination is written. On passing this examination a student is admitted to the final year in which he goes on with the third-year syllabus but in greater depth.

In order to gain insight into the nature of the Main Course in Mathematics the following review of all Mathematics syllabuses in the colleges as given by the report of the Mathematics section of the Association of Teachers in Colleges and Departments of Education is of interest. This report entitled "Teaching Mathematics - Main Courses in Colleges of Education" gives the following as an example of the topics covered in a Main Course Mathematics syllabus (1, p. 84):

"List of Topics

(1) Basic set language.

Elementary operations and notation. Symmetric difference, set difference, solution sets.

(2) Boolean Algebra.

Venn diagrams, Lewis Carroll problems, empirical establishment of laws, simple manipulation in Boolean algebra, switching circuits, propositional calculus, truth tables, implication, equivalence, duality.

(3) Operations, relations and mappings.

Investigation into the results of applying various operations to physical and intellectual systems, relations as sets of ordered pairs, cartesian product, functions, papygrams, graphing of inequalities, linear programming by graphical and simple algebraic methods in two and three dimensions, equivalence and order relations, transformations, (permutations, algebraic and geometric.)

(4) Group structure.

Stage A investigations of symmetry, finite and infinite arithmetic, and permutation groups. Isomorphism. Stage B investigation of - sub-groups, cosets, factor groups, normal sub-groups. Stage C treatment of elementary group properties.

(5) Fields and Rings.

Examples from modular arithmetics, polynomials congruent to a modulus, extension fields, rings.

(6) Matrices, determinants and vectors.

Transformations, inverses as products of elementary matrices, determinants - their elementary manipulation and use in the solution of equations, incidence matrices, isomorphisms with number-systems, tabulation, solution of equations. Stochastic matrices. Vectors as number n-tuples and as equivalence classes of directed line-segments, applications to geometry and mechanics. Scalar and vector products.

(7) Number systems.

Build-up of complex numbers from natural numbers, with reference to solution of algebraic equations and to the search for systems with group properties. Definition and investigation of integers and rationals as equivalence classes of pairs of natural numbers. Intuitive considera= tion of the problem of constructing the reals. The complex number field.

(8) Complex number theory.

Argand diagram. De Moivre's theorem for rational exponents, complex roots of equations. Complex number products, loga= rithmic, exponential and trigonometric relations in C X C. Euler's formulae. Conformal mapping.

(9) Elementary Number Theory.

Congruence to a modulus. Recurring decimals. Euclid's algorithm. Infinity of primes. Pythagorean triads. Fermat's theorem. Goldbach conjecture.

(10) Topology

Genus. Topological equivalence. Networks. Representation of polyhedra Euler's theorem. Graph theory. Knots.

(11) Probability and Statistics.

Sample spaces. Probability mappings. Conditional probabi= lities. Bayes' theorem. Binomial, Poisson, and Normal distributions. Measures of central tendency and dispersion. Correlation. Regression. Levels of significance. Sampling techniques. Hypothesis testing.

(12) Co-ordinate Geometry.

Parameters. Loci. Simple properties of parabola, ellipse, rectangular hyperbola. Further study of conic sections. Envelopes. Three-dimensional geometry with vectors. Polar co-ordinates. Study of curves other than conics. Curve sketching, including graphs of rational functions.

(13) Calculus and Analysis.

Differentiation and integration; a critical examination of their meaning and purposes. Some differential equations, including second order with constant co-efficients. D operator. Applications to co-ordinate systems other than Cartesian. Partial differentiation. Definite integrals as functions of their limits. Continuity Limits. Conver= gence. Homomorphic properties of limits.

(14) Numerical Methods.

Numerical differentiation and integration. Solution of polynomial equations. Iterative methods. Error analysis. Relaxation methods. Preparation of Flow Charts. Degree of accuracy. Computer programming.

(15) Mechanics.

Applications of equations of motion via differential equations. Friction. Centres of gravity. Conservation of energy and momentum. Moments of inertia. Harmonic motion. Central orbits. Motion in two dimensions. Re= lative velocity. Resolution and composition of forces. Analytical consideration of coplanar forces, using vector methods. Stability of equilibrium. Moments.

(16) Vector Spaces.

Eigenvectors. Independence, basis and dimension. Definition of vector space. Subspaces. The equations A.X=B. N-dimensional geometries.

(17) Geometries.

Consideration of Euclidean and non-Euclidean geometries. Affine geometry. Projective geometry.

(18) Axiomatics.

Axiomatic treatment of some systems, such as Boolean alge= bra, group structure, probability. Discussion of nature of axiomatic system by setting up a set of axioms concerning some undefined elements, and investigating the possible logical development. Some attempt at axiomatising a familiar system. The search for a minimum set of axioms."

The above syllabus may be looked on as a union of syllabuses with the italicised portions as an intersection, but many colleges do not cover all the italicised items, nor do they confine them= selves to the items listed above. In the past this syllabus was covered in three years with roughly five hours per week allocated during the first two years and six in the third year (1, p. 83). This syllabus is now covered in the first two years presumably with amendments to the syllabus itself and to the time allocation. On the successful completion of the Main Course in Mathematics the following syllabus is followed during the third and fourth years at Durham University (14, p. 659):

"1. History, content and presentation of school Mathematics.
2. The development of mathematical ideas.
3. School Mathematics from an advanced viewpoint.
4. Analysis, real and complex variables.
5. Metric spaces.
6. Algebraic systems and structures.
7. Geometry."

One examination on the above syllabus is written at the end of the third year for the "Qualifying Examination" and two for the "Final Examination" at the end of the fourth year. The Applied Mathematics syllabus which is compulsory for students taking the main course in Mathematics, is as follows (14, p. 659):

"1. The history and presentation of Applied Mathematics, the concept of a mathematical model, problem solving in Mathe=
2. matics.
3. Mechanics.
4. The formation and solution of differential equations.
5. Numerical analysis.
6. Probability and Statistics.
7. Linear programming and operational research."

One examination is set for the "Qualifying Examination" and two for the "Final Examination".

b. Professional training

Changes have also taken place as regards the content of the professional training courses as a recent lecture delivered at the Second International Conference of Mathematical Education at Exeter in 1972 indicates: A typical Methods Course for Mathe= matics at colleges of education in England and Wales covers the following aspects (44, p. 3):

"1. Practical work with children in small groups during teaching practice, but also during regular sessions at local schools.
2. Lectures and seminars on the teaching of mathematical topics, the aims of Mathematics teaching, class organization and the development of a curriculum.
3. A study of a modern set of prescribed books and syllabuses.
4. A study of visual aids such as television, tape recorders and film strips.
5. A spiral study of topics such as Computer Science and Statistics.
6. A study of the History of Mathematics as a subject."

As regards the professional training of prospective Mathematics teachers the above-mentioned report by the Mathematics section of the Association of Teachers in Colleges and Departments of Education (1) emphasises that in order to train a student to be a good Mathematics teacher, one must distinquish between two aspects, namely the <u>learning</u> of a range of mathematical ideas and techniques, and the development of the ability to <u>do</u> Mathematics (1, p. 3). The second aspect is the one most often neglected. In consequence of the traditional method of training he has received, the Mathematics Teacher has usually only had experience of <u>learning</u> mathematical concepts without ever having had the opportunity of <u>using</u> them. By the <u>use</u> of Mathematics a distinction is made between problems set as exercises on specific topics just learnt in order to establish the ideas securely, and problems which exist in their own right and for which no method of solution is given (1, p. 4). The Report stresses the fact that it is the exploration of these more open problems which results in real mathematical activity and experience. This experience of being creatively active in one's subject has proved to be very beneficial to the teaching of subjects like English and Arts and Crafts, that is, if the teacher actually writes poems or paints. Whether the results attain a sufficiently high standard for publication or not is of no importance. What does matter is that the teacher has the experience of personal involvement in the activity.

A Mathematics teacher, therefore, who takes an active interest in mathematical problem-solving at his own level, does not need arguments to convince him that rote learning of algorithms has little to do with mathematical activity (1, p. 4). For this reason the Report recommends that there should be two strands of work running throughout a mathematical course for prospective Mathematics teachers, namely a strand exclusively pertaining to the learning of new mathematical content, and another concerned with the development of the ability to institute mathematical investigations (1, p. 4).

As far as the first strand of the Mathematics course is concerned, the Report recommends that the following topics should be part of any course offered to prospective teachers of Mathematics during their training:

(i) Number systems, algebras and algebraic structures.
(ii) Functionality.
(iii) Geometry.
(iv) Applied Mathematics
(v) Statistics.
(vi) Astronautics.

As regards the second strand of the prospective Mathematics teachers' training the aim should be to encourage and help students to work independently at their own investigations. Some of the techniques which the student should master are:

"a. Formulating a problem in mathematical terms, inventing suitable symbols and/or diagrams.

b. Using existing literature - classifying the problem and so recognising its similarity to problems already solved, and to bodies of known theory; making use of theorems or methods from the literature to solve the problem.

c. Making observations, conjectures, inductive generalisations.

d. Constructing proofs of the conjectures and generalisations arising from (c); using various types of proof or disproof; reductio ad absurdum, counter-example, mathematical induction; seeking the essential conditions for the truth of a property.

e. Extending the problem, varying the conditions, asking 'what would happen if ....'; seeking generalisations.

f. Taking particular cases if general cases prove difficult.

g. Breaking down a problem by classifying different cases, ordering them, and dealing with them, successively.

h. Systematising - collecting a group of results into a logically ordered system.

i. Axiomatising - constructing axiom systems for bodies of theory; varying axioms and investigating resulting systems.

j. Constructing algorithms for the solution of problems.

k. Guessing solutions which are then improved systematically.

l. Obtaining numerical solutions using iterative machine methods" (1, pp. 14–15).

As a result of this Report seminar workshops were established to give attention to the creative and productive activities which are essential for a teacher. Students are especially shown and encouraged to make their own mathematical apparatus, teaching aids and filmstrips or are simply encouraged to do their own research or prepare their lessons.

Micro-teaching (mini-teaching)

This form of teaching practice originated in the United States of America and has become popular in training colleges in England and Wales: A student gives a lesson to a group of pupils which is recorded on a video-tape. Afterwards the lesson is shown to all the students and discussed. The advantages of this use of the video-tape are that the lesson is shown to all the students and discussed. The advantages of this use of the video-tape are that the lesson is not disrupted by having a whole group of students observing it, the video-tape can be replayed or stopped at will during the discussion afterwards and finally, because it is a film of a class mate, the students view the film with great interest.

In England and Wales just as in the United States of America, more and more emphasis is being placed on the practical side of teacher training and greater student participation in classroom activity during teaching practice is continually being emphasised (44, p. 6). It is significant that the James Report recommends that the second two-year professional training period of the four-year secondary teacher's diploma should be split in such a way that the theoretical side is completed in the third year while the final year is devoted entirely to teaching practice.

c. In-service training

In 1965 the Report on In-service Training for Teachers of Mathematics was published by the Joint Mathematical Council of the United Kingdom. This report was considered so important that it was reprinted with an introduction in 1972 (26). In this report the following problems in connection with the in-service training of Mathematics teachers were highlighted (26, p. 4):

1. In-service training courses are attended only by a small percentage of teachers, usually the enthusiastic little group.

2. The general shortage of teachers ensures that the full-time in-service training of teachers for a term or more is completely impractical.

3. Short courses are presented at Mathematics conferences and the activities of the Mathematics Association does not carry the necessary knowledge over to the teachers effec= tively.

4. This ineffective transmission of information occurs because the presentation of these courses depends on the part-time or voluntary contributions of persons with many other responsibilities.

5. The attendance of teachers is not only a voluntary matter, but also a spare-time activity which is seldom without cost to the teacher.

6. Teachers in the primary schools are responsible for other subjects as well, subjects that also require attendance at refresher courses. One subject's course may just be over when the next starts, resulting in a prolonged absence from one class if the teacher attends both. Teachers may therefore be asked to choose one refresher course only, and that may not be the Mathematics course.

These problems are to be found in the South African set-up as well and it is of special interest therefore to see what solutions were recommended in the report. The report recommended that a Teachers' Centre should be established in every area in England and Wales where a group of schools can work together. The teachers' centres were to operate in the same way as the Seminar Workshops at the colleges. Books, apparatus and a well equipped workshop, all under the supervision of a full-time warden, were envisaged. These recommendations were carried out especially in the larger cities. A few Teachers' Centres consisting of a large workshop, a kitchen and comfortable rooms for discussions were built. Other centres were established in old school buildings while others simply comprised of a class-room in a school which the pupils were also allowed to visit during the school day. There are about 500 of these teachers' centres in England and Wales at present.

The success of the teachers' centres was underlined in a lecture delivered at the Mathematics Conference at Exeter in 1972 (22). Primary and secondary teachers visit the teachers' centres regularly, but what was found to be particularly significant is that sessions in which the teachers could actively take part, such as workshop activities, were much better attended than any of the formal lectures (22, p. 1). No credit or remuneration is, however, given for attendance at the teachers' centres.

Of special interest are the numerous in-service courses becoming available for teachers to re-orientate themselves on their sub= jects during school holidays. The courses are generally of one week duration and the emphasis is on active and practical involvement on the part of the teachers attending the course. These courses are organised by the Department of Education and Science for teachers engaged in educational service in England and Wales. Attendance is voluntary, and there are no examinations and no form of certification (16). Typical courses are the following:

"N.320 MATHEMATICS IN THE CURRICULUM FOR JUNIOR, MIDDLE AND LOWER SECONDARY SCHOOLS (8 TO 13 YEARS)

September 1st to September 6th 1975
Avery Hill College of Education, London
Applications by June 20th 1975
This course is intended to help teachers to make the most of opportunities for developing the mathematical possibili= ties of some chosen topics. Opportunities will be provided for:-

1. Planning topics for the classroom.
2. Learning more mathematical background required.
3. Discussing the value of a variety of equipment and books. Most of the sessions will be practical, planning or discussion sessions.

The course is for:-

a. Teachers from junior, middle and lower secondary schools throughout the ability range and from schools for the handicapped.
b. Lecturers from colleges of education.
c. Advisers and inspectors from local education authorities." (16, p. 12).

"N. 367 MATHEMATICS (11 TO 16)

April 10th to April 18th 1975
Ripon College of Education
Applications by January 31st 1975
This course is designed for those teaching mathematics (not necessarily specialists) to pupils in the age-range 11 to 16.

Course members will spend much of their time in small working groups studying a variety of mathematical topics at their own level. There will also be opportunities to consider in detail methods of approach, problems of classroom organisation, and the use of simple resources in presenting material. Visiting speakers well known in the world of mathematical education will also contribute.

The director would be very interested to have requests for both working and discussion topics in order to tailor the course to the needs of the members." (16, p. 26).

A further notable development as far as the training and in-service training of Mathematics teachers are concerned, is the post-graduate certificate course tailored specifically to the needs of Mathematics teachers. The following is the curriculum of the Specialist Mathematics Course insti= tuted at the University of Hull for practicing teachers:

"HULL (INSTED), Specialist studies (mathematics), Diploma, 1 year full-time (degree, teaching qualification and 2 yrs experience); secondary education in England with ref to curriculum (range and variety of secondary education inc sociological problems, gen learning theory, developmen= tal studies of young people during adolescence), teaching of a selected subj (for math inc study of recent researches information of math concepts, observation of methods in current use and evolution of math in primary schools, scope of subj teaching at various levels in secondary schools, classroom methods, role of subj as a principal study, role of subj in relation to other subjs of curriculum comparative study of subj content and teaching methods in some other countries), and selected study of some pt of sp subj (for math eg set theory, gps, matrices, vectors, stats and probability and numerical analysis)." (43, p. 845).

A similar specialist course has also been introduced at the University of London. This course, however, has a more informal approach:

"LONDON. (Chelsea). Science/mathematics education. Certificate, 1 yr f-t (degree in sciences, mathematics or related subjects for grads wishing to teach); course operates in close co-operation with practising teachers; based on lab. work and exploratory study groups with minimum of formal lectures; specialist studies in biol. chem. maths, physics or integrated science, and also 'integrated studies' which explore links between other sciences and maths: 2 periods teaching practice (intro period at beginning of session and nearly all 2nd term); plus residential field courses (practical studies in integrated science combined with outdoor activities e.g. mountaineering, sailing, pony trekking etc); no formal exams since assessment continuous." (43, p. 150).

5.3 THE TRAINING OF MATHEMATICS TEACHERS IN THE NETHERLANDS

5.3.1 Introduction

In the Netherlands, just as in most of the Western countries, reforms have taken place in the educational system. In 1968 a new education law, known as the "Mammoetwet", was passed in the Netherlands. The reorganising of the education system aimed particularly at breaking down the rigid barriers between the various types of school in order to give every child an equal opportunity of attending a university one day. The new legislation affecting the school system made the reorganization of teacher training imperative and planning in this field was begun well in time. A commission known as the Commissie Opleiding Leraren (COL) was called into being under the chairmanship of Dr. J.B. Drewes in 1964. In 1966 the first Interim Report appeared and in 1971 the second.

5.3.2 The training of primary school Mathematics teachers

Primary school teachers are almost exclusively trained at teachers' training colleges. At present there are 44 Catholic teachers' training colleges, 28 Protestant, 24 Public and 2 others (33, p. 59). The colleges all offer the same courses and students all write the same final examinations which are controlled by the Ministry of Education and Science. The duration of the training course is three years for holders of the Hoger Algemeen Voortgezette Onderwijsdiploma (HAVO). The training is split into two phases ("leerkringe"), the first of which is spread over two years and the last over one year. After the successful completion of the first phase a student receives a teaching diploma and after the successful completion of the final year a student receives a diploma qualifying him as "volledig bevoegde onderwyser". Male students usually all complete the three years but about 50 per cent of the female students leave after the first phase, probably because they are contemplating marriage (17, p. 84).

The training course during the first phase consists of the following subjects (15, p. 765):

"Education: psychology of education and child psychology, didactics and an introduction to the didactics of the primary school subjects	280 lessons
Knowledge of the cultural and social environment	120 lessons
The Dutch language and literature and its didac= tical aspects	280 lessons
Music and its didactical aspects	240 lessons
Drawing and its didactical aspects	160 lessons
Handicrafts and its didactical aspects	160 lessons
Physical Education and its didactical aspects	160 lessons
History and its didactical aspects	80 lessons
Geography and its didactical aspects	80 lessons
Nature Study and its didactical aspects	80 lessons
Biology and its didactical aspects	80 lessons
Arithmetic and its didactical aspects	80 lessons
Writing and its didactical aspects	40 lessons
Road Safety and its aspects	20 lessons
Speech Therapy and its didactical aspects	10 lessons"

For the second phase the folllowing subjects are laid down as the minimum requirement (15, p. 766):

"Education: psychology of education and child psychology	180 lessons
The Dutch Language and its literature	140 lessons
Knowledge of the cultural and social environment	70 lessons
Physical Education	70 lessons
Didactics	140 lessons"

It is interesting to note that whereas traditionally the three R's, Reading, Writing and Arithmetic, were considered basic to the education of the primary school child, Arithmetic does not feature very prominently in the above curriculum. Reading and Writing on the other hand do occupy a more prominent position.

5.3.3 The training of secondary school Mathematics teachers

a. Introduction

Since 1968 teacher training courses have been modified to fall in with the new secondary school system as prescribed by the Mammoetwet. At present there are three teachers' certificates which qualify a person to teach in a secondary school in the Netherlands. In order to qualify to teach in the higher classes of the Gymnasia and Athenea as well as in the two highest classes of the HAVO schools, a teacher must obtain a first-class teacher's certificate. A second-class certificate is required in order to teach the first grade of the Gymnasia and Athenea or the three lower grades of the HAVO schools, while at least a third-class teacher's certificate is required to teach in the lower and middle classes of the Middelbaar Algemeen Voort=gezette Onderwijsscholen (MAVO schools). In order to acquire a first-class teacher's certificate at least five years of academic and professional training is required. A second-class certificate requires four years of academic and professional training and a third-class certificate three years (33, p. 58).

b. Academic training

At present it is still being debated whether teacher training should be entrusted to the universities or to pedagogical in=stitutes independent of the universities (57, p. 26). A uni=versity degree (doctorandus, which is a first degree) is a necessity for anyone withing to qualify for a first-class teachers' certificate however. For the doctorandus qualification students take two or at the most three subjects for a minimum period of four years. The aspirant Mathematics teacher will take Mathematics as his main subject and Physics as his second subject. It often happens that a teacher with these subjects will teach both of them later in the schools. The Mahtematics course covers topics such as Advanced Algebra, Advanced Geometry, Analysis, Differential Equations, Theory of Complex Functions, Numerical Analysis, Probability Theory, Number Theory and Applied Mathematics (57, p. 28). No distinction is made in the course between students who wish to teach Mathematics in the schools later on and students who wish to follow other professions.

The COL has put forward the following recommendations with regard to the Mathematics training required for second- and third-class teachers certificates (7, p. 9):

TABLE 5.2

RECOMMENDED NUMBER OF HOURS REQUIRED FOR THE 2ND AND 3RD CLASS TEACHER'S DIPLOMAS OVER THE FOUR YEARS OF TRAINING FOR THE 2ND CLASS AND THREE YEARS FOR THE 3RD CLASS IN MATHEMATICS

Subject	2nd class	3rd class
Method	3 year-hours*	2 year-hours*
Algebra	9 year-hours	6 year-hours
Analysis	9 year-hours	6 year-hours
Geometry	3 year-hours	2 year-hours
Statistics	4 year-hours	4 year-hours
Computer	5 year-hours	4 year-hours
TOTAL	33 year-hours	24 year-hours

* One year-hour indicates one hour per week for one year

The 33 and 24 year-hours are spread over the four years as follows (7, p. 9):

First year:	9 hours per week)	24 hours per week for 3rd
Second year:	7 hours per week)	Class Teacher's Certificate
Third year:	8 hours per week)	
Fourth year:	9 hours per week	(2nd Class Teacher's Certificate only)
	33 hours per week	

The above applies to a student majoring in Mathematics. Students have to take two major subjects each of which is subject to the above time distribution. At present the 2nd and 3rd class courses are offered by teachers' training colleges but as has been mentioned above a decision must still be made as to the future role of these colleges and the universities.

The Commissie Opleiding Leraren recommends the following Mathematics syllabus for the 2nd class certificate. The same syllabus is applicable for the 3rd class certificate except that the more difficult sections are omitted (7, p. 9 - 10):

"1. Mathematics Method:

Theory of Sets, logic, mathematical language, whole numbers and complete instruction.

2. Algebra:

Groups with applications to arithmetic and geometric rings, in particular to polynomial rings, prime factorisation, fields; Quotient fields of one domain; algebraic and transendental expansions. Vector spaces, linear dependency, bases, co-ordinates, linear mappings, matrices, Eigenvalues, determinants, the theory of linear equations, in and out products, ortonormal bases, trigonometric forms, orthogonal and symmetrical mappings with main axes in the normal form, convex figures and the principles of linear programming.

3. Analysis:

Elementary topological principles in analytical context. Theory of real and complex numbers. Introduction to the main techniques of differential and integral calculus in one or more unknowns. Rational and simple algebraic functions, exponential functions, logarithms, trigonometric and cyclometric functions, maxima and minima, elementary differential equations, in particular specific linear differential equations pertaining to vectors. The concept of differentiability of complex functions; the exponential function and related functions as a complex function. Infinite series, power series, Fourier series, evenly convergent. Numerical Mathematics, approximation, interpolation, squaring, non-linear equations, results of finite precision.

4. Geometry:

Topics related to school Geometry.

5. Statistics:

Descriptive statistics: elementary probability theory (with finite probability); stochastic parameters, expectation values, variancy; the law of large numbers, the normal dis= tribution; the Poisson distribution. Simulation: Elementary examples of the testing of hypotheses.

6. Computer Science:

Elementary algorithmetic concepts such as block scheme, allo= cation of value, conditional commands, subrouting. Knowledge and use of one or two programmes (ALGOL, FORTRAN, COBOL). Principles of the working of a computer such as address, basic cycle, machine language, the principle that data can become work to be done, the possibility of "assemblers", "compilers" and "hardware". Principles used in programmes, "interrupt", "multi-running and time sharing", "multi-access" and "conver= sation". The organization of a computer centre. Knowledge of the principles of a number of the most important uses of computers."

c. Professional training

A visit by one of the Human Sciences Research Council's researchers to Britain and Europe in October 1972 revealed that the Dutch have given body to the thought that a specific Didactics of Mathematics Course is essential in the training of Mathematics teachers. The Rijksuniversiteit Utrecht, for instance, offers its students a thorough Didactics Course in Mathematics. Because of the fact that this Didactics Course appears to be the most thorough of all the overseas Didactics Courses which were en= countered, it is of value for this study to give the contents of the course in full (see Appendix B). The course was devised by J. van Dormolen of the Mathematics department of the Rijks= universiteit Utrecht. One hour per week is devoted to the course.

Of special interest for this study is the way in which the implementation of new Mathematics programmes is organised in the Netherlands. After initial mistakes in the implementing of new Mathematics syllabuses in the schools, the Dutch authorities realised that -

1. renewal of Mathematics syllabuses as regards content only has very little effect;

2. for the effective implementation of new material in the syllabuses detailed methodological advice and aid in the form of experimentally tested textbooks must be made available, and

3. changes in the content of the syllabuses must take place in consultation with practising teachers during in-service training courses and should not occur solely as a result of the possible experimental implementation in special schools beforehand (21, p. 6).

In 1971 the planning and implementation of renewal as regards Mathematics syllabuses was organised on a centralised basis under the Instituut voor Ontwikkeling van het Wiskunde-onderwijs (IOWO).

Curriculum development is undertaken by the IOWO in four phases, namely:

1st Phase: Compiling experimental study guides and other study material for specific topics. Special attention is given to the method of teaching the material.

2nd Phase: The evaluation and improvement of the experimental material in "project" schools. IOWO's personnel visit these schools and through lectures and dis= cussions iron out any difficulties the teachers may encounter. The teachers' suggestions as to any improvements are followed up carefully. The teachers of these "project" schools receive extra remuneration for the extra time and work involved.

3rd Phase: After the experimental material has been revised, teachers throughout the country are invited to attend training courses as regards the new material. Such courses could be spread over two years and consist of twenty two-hour sessions presented by IOWO's personnel and university lecturers.

4th Phase: During this phase the new material and methods are integrated into the existing syllabuses in order to form an integrated whole which can be implemented on a country-wide scale (21, p. 8).

The above planning with regard to the implementation of new syllabuses stands in sharp contrast to that of England and Wales, for instance where the school system is to a very great extent decentralised. Each of the 163 counties in England and Wales has its own elected education body which controls education in its county. In England and Wales there is no compulsory national school-leaving examination but nine examining bodies exist which are independent in all respects with the exception that the School Council keeps an eye on the standards. Head= masters are free to choose whatever examining body they wish for the pupils of their schools. All this makes it very easy to launch new experiments once these are approved of by the School Council, but it must be kept in mind that that which works well in a decentralised education system is not likely to succeed in a country with a more centralised education system like the Republic of South Africa, even if it is only centralised along provincial lines. For this reason it is perhaps more important to take a closer look at the way in which reform and renewal is being introduced in the Netherlands than to stare oneself blind at a decentralised system's renewal programme, however admirable it may be.

5.4 THE TRAINING OF MATHEMATICS TEACHERS IN BELGIUM

5.4.1 Introduction

Belgium too has instigated changes in its school system and teacher training programmes in order to try and adapt to the many changes taking place in the wake of technological advances. In 1957 already changes were brought about in the structure of teacher training aimed at making the teaching profession more attractive to young people. The most significant changes, however, came into effect on 1 September 1970 after lengthy discussions between the Rijks group and the Catholic group in Belgium. Under the new dispensation which will be in full swing in 1974, two years of training after acquisition of the higher school-leaving certificate (the Humaniora) will be required for the nursery school diploma, the primary teacher's diploma and the lower secondary teacher's diploma. Differentiation as regards the salary structure of teachers will still be maintained, however.

There are two ministries of National Education in Belgium, one for the French speaking Walloons and one for the Dutch speaking Flemish, each with its own minister. The two ministries must reach agreement on national issues of policy but it happens that the two ministries agree on the system of education while pro= pagating two completely different programmes of education. Apart from this, great differences exist between the programmes of the Rijks and Catholic groups (10, p. 245). There are a great number of teachers' training colleges in Belgium. Primary school teachers are trained at "lower" teachers' training colleges while teachers for the "lower" secondary school levels are trained at "higher" teachers' training colleges. Many of these training colleges are for women only (10, p. 254).

5.4.2 The training of primary school Mathematics teachers

It has already been mentioned that differences exist between the teacher training programmes of the Rijks and Catholic groups and that, furthermore, differences also exist within the Rijks group between the Walloon and the Flemish teacher training programmes. In short, there are three different teacher training approaches within the same educational system, namely the Walloon Rijks education, the Flemish Rijks education and the Catholic education. The subjects and hours per week set aside for them may be seen in the following tables (10, p. 245 - 247):

TABLE 5.3

THE WALLOON LOWER NORMAL TEACHER'S DIPLOMA COURSE

	Subject	Hours per week
First year	Psychology of education and didactics	16
	Milieu exploration	$4\frac{1}{2}$
	Mother tongue	3
	Mathematics	3
	Physical education	2
	Music education	2
	"Plastic education"	2
	Religious or moral education	2
	Second language	2
	Dactylography	2
		$38\frac{1}{2}$
Second year	Psychology of education, didactics and teaching practice	17
	Milieu exploration	$1\frac{1}{2}$
	Mother tongue	3
	Mathematics	2
	Physical education	$2\frac{1}{2}$
	Music education	2.
	"Plastic education"	2
	Philosophy of science	1
	Audio-visual aids	1
	Religious or moral education	2
	Second language	2
		36

TABLE 5.4

THE CATHOLIC LOWER NORMAL TEACHER'S DIPLOMA COURSE

	Subject	Hours per week
First year	Religious Education	3
	Psychology of Education, Didactics and Teaching Practice	13
	Sociology	1
	Mother tongue	4
	Mathematics	2
	Milieu exploration	3
	Second language	1
	"Plastic education"	2
	Music education	2
	Manual training	1
	Physical education	2
		34
Second year	Religious education	3
	Psychology of Education, Didactics and Teaching Practice	16
	Sociology	1
	Mother tongue	3
	Mathematics	2
	Milieu exploration	3
	Second language	1
	"Plastic education"	2
	Music education	2
	Physical education	2
	Manual training	1
	Hygiene	1
		37

TABLE 5.5

THE FLEMISH LOWER NORMAL TEACHER'S DIPLOMA COURSE

	Subject	Hours per week
First year	Psychology of Education and Teaching Practice	12
	Mother tongue	2
	Mathematics	2
	Geography	$1\frac{1}{2}$
	History	2
	Science	$2\frac{1}{2}$
	Physical education	3
	Music education	3
	"Plastic education"	3
	Second language	2
	Moral education	2
	Audio-visual techniques	1
		37
Second year	Psychology of Education and Teaching Practice	17
	Mother tongue	1
	Mathematics	$\frac{1}{2}$
	Geography	$\frac{1}{2}$
	History	$\frac{1}{2}$
	Science	$\frac{1}{2}$
	Physical education	3
	Music education	3
	"Plastic education"	3
	Second language	2
	Moral education	3
		34

On the face of it the first two curricula do not differ much although the Catholic approach presumably differs greatly from that of the Walloons. The Flemish curriculum shows more marked differences. Also as far as teaching practice is concerned, the Flemish organization differs from the others. Whereas the Catholic colleges have a teaching practice period of three weeks in the first year and six weeks in the second year, the Flemish colleges concentrate on club activities, youth work, educational excursions and vocation colonies, all extra-curricular, during the first year. During the second year three two-week periods of teaching practice are arranged for the students (10, p. 246). Unfortunately the actual content of the Mathematics courses done at these colleges could not be obtained.

5.4.3 The training of secondary school Mathematics teachers

The majority of teachers teaching the lower classes of the secondary schools receive their training at a higher normal college. The training course lasts two years and for admission students must have a Humaniora Certificate. The Humaniora compares with the Abitur in Germany and the Advanced Level Certificate in England and Wales, all of which are considered to be of a very high academic standard. Once a student has successfully completed the two-year training course at the normal college he receives the Geagregeerde Lager Secundair Onderwijs=diploma, also known as the Regentdiploma because of the teacher being called a "regent". The "regent" is trained specifically to help children bridge the gap between the primary school with its class-teaching system and the secondary school with its subject-teaching system. He (the "regent") therefore specialises in more than one subject so that he can teach more than one subject at the lower secondary school level. The curriculum at the higher normal colleges for aspirant "regents" is as follows (10, p. 251): Dutch-English, Dutch-moral code or Dutch-History, French-History, Mathematics, Science-Geography, Physical Education-Biology, Plastic art (for men only) and an optional subject. The above subjects are not done on a purely academic basis. The Subject didactical aspects of these subjects are included in the lectures. Lectures in the mother tongue, Gene=ral Didactics and Pedagogics as well as Psychology are also included in the curriculum. At present the above curriculum for the Geaggregeerde Lager Secundair Onderwijsdiploma is under review as two years of training is considered insufficient.

Teachers who wish to teach in the higher classes of the secondary schools must obtain a degree, known as a "Licentiaat", at a university. Normally four years of study is required to obtain a "Licentiaat". At the end of the first two years students write the "Kandidaatseksamen" which they must pass before they can continue for the final two years necessary for the licen= ciate. A student who has passed the licenciate examination has specialised in one or at the most two subjects. The subject in which the student has specialised is mentioned on the diploma, for instance "Licentiaat Wiskunde". In order to qualify as a teacher, however, a further year of professional training is required for the "Aggregaatdiploma". In 1971 the curriculum for this professional year of study was as follows (10, p. 252):

1.	General method, experimental education with emphasis on a psycho-pedagogical study of the learning process, and the History of education	60 hours per year
2.	Subject Didactics	30 hours per year
3.	Teaching Practice	30 hours per year

Further training is also laid down with regard to the following subjects for students wishing to become Mathematics Teachers (10, p. 253): Classical, Romance and German Philology, Mathe= matics, Physics, Chemistry, Biology, and Geography.

In-service training of teachers in Belgium has always been considered very important especially when it comes to introducing new syllabuses. The first new Mathematics syllabuses were introduced on an experimental basis in a few schools in 1958. Between 1958 and 1961 a great number of orientation courses were organised by the Ministry of National Education and Culture for teachers in service. In 1961 the Belgian Centre for Method of Mathematics teaching (BCMW) was established specifically to help teachers with the new syllabuses. The following year fifteen study groups were established by the BCMW throughout Belgium in order to reach as many Mathematics teachers as possible. In short it is significant that right from the outset Mathematics teachers, by means of experimental teaching, actively took part in the planning and implementation of the "new" Mathematics in Belgium (21, p. 31).

The above-mentioned, however, is a system of implementing new syllabuses - a system which necessarily required orientation courses. Over and above these, however, there do not seem to be other forms of in-service training by means of which teachers can improve their qualifications for increases in salary. At present in-service training in Belgium is being investigated with a view to improving the situation (10, p. 254).

5.5 THE TRAINING OF MATHEMATICS TEACHERS IN WEST GERMANY

5.5.1 Introduction

In order to see the training of Mathematics teachers in West Germany in perspective, it will be necessary to give a short account of the school system there. The general school training in West Germany is as follows: From his sixth year a child attends a Grundschule till his tenth year. He may then go either to a Hauptschule (grades 5 to 8), or to a Realschule (also known as a Mittleschule) where he can progress as far as grade 10, or to a Gymnasium where he can complete his school career with grade 13 and sit for the Abitur examination. Mathematics is a compulsory subject for this examination (21, p. 14). On passing the Abitur examination a pupil receives a Reifezeugnis certificate which constitutes the minimum entrance requirement to a university. A pupil can also enter a Gymnasium for grades 11 to 13 if he fared particularly well in the final examinations of the Realschule (the Mittlere Reife examination), or he can go to a Hochere Fachschule or an Ingenieurschule if he did not fare quite well. Both the last-mentioned are professional schools offering three-year professional courses which allow pupils to apply for entry to a technical university. Apart from the form and content of the Abitur examination, all other school examinations are completely internal examinations. Apart from the above-mentioned types of schools there are also a few Gesamtschulen or comprehensive schools which contain all the others in one.

Teachers for the Volksschule (Grundschule and Hauptschule, that is for grades 1 to 8) are trained in Pädagogische Hochschulen. The Abitur is the minimum entrance qualification and the training course is of three years' duration, at the end of which the first State Examination is written. However, before this first State Examination may be written a separate preparatory examination, known as the Philosophicum, must be passed in Philosophy and Education Theory. Once the student has passed the first State Examination, he is appointed a student teacher (Studienreferendar). He does not receive a salary but only an allowance. The first year of this appointment is spent at a training college (Anstalsseminar) where the student teacher does practice teaching and attends seminars, while the second year of his appointment as student teacher is spent at a district seminary (Studienseminar). At the end of this second year the student must sit for the Second State Examination (Pädagogische Prüfung) which entails two or three criticism lessons before an examination panel, an oral examination on Pedagogy and Education Law and a dissertation on a problem in education which he has experienced himself. The successful student then receives a temporary appointment at a school as Assessor. Only after a few years does he receive a permanent post as Studienrat.

The training of secondary teachers for the Realschule (grades 8 to 10) differs from that of teachers for the Grundschule only in respect of the first stage, since these aspirant teachers do not go to the Pädagogische Hochschule but to a university for a three- or four-year degree. After obtaining this degree the same training is followed for the Second State Examination till the final appointment as Studienrat. Teachers for the highest grades in the Gymnasiums (grades 10 - 13) must also have a university training, but must obtain a further degree which usually requires a further two or three years study. Once again the same path is followed for a permanent appointment as is followed by the other aspirant teachers.

Technical school teachers receive their academic training at university or at a technical university. The duration of their studies there is three to five years. Their academic training is concluded with the First State Examination and once again the above-mentioned path for appointment as Studien=rat is followed.

5.5.2 The training of primary school Mathematics teachers

As has already briefly been mentioned, teachers for the primary schools attend Pädagogische Hochschulen for three years and the minimum admission requirement is the Abitur. The Pädagogische Hochschulen are either autonomous institutions or are affiliated to a neighbouring university. The training at these teachers' training colleges is of such a uniform nature that students, on qualifying as teachers, can freely apply in any of the Länder for a teaching post. At present about 10 to 15 per cent of the students admitted to the training colleges do not possess the Abitur qualification. These students, however, are admitted only after they have written an admission examination. Since Mathematics is a compulsory subject for the Abitur (although pupils who did not follow the mathematical-scientific direction at gymnasium do not take such advanced Mathematics) the students all have a solid foundation in Mathematics when they arrive at the Pädagogische Hochschule.

The curriculum is as follows (5, p. 262):

"Philosophy;
Psychology;

Sociology;
Politology;
The study of an optional subject (for example Mathematics);
Didactics of the optional subject, and
Didactics of two other school subjects."

Unfortunately, the syllabuses for Mathematics and the Didactics of Mathematics were requested but have not yet been received. The optional subject, Mathematics in this case, has the repu= tation of being of high academic standard. In fact the academic side is often accentuated at the cost of the didactical aspects. A survey made during the 1969 - 1970 academic year revealed that the didactical aspects of Mathematics made out 34 per cent of the Mathematics training received by primary school teachers. However, these figures differ from state to state, the figure for Hamburg being 17 per cent and that for Berlin 53 per cent (25, p. 12). The belief that Didactics is not a collection of recipes and that a scientific approach is essential for the methodological aspects of teaching is, however, gaining ground (12, p. 263).

5.5.3 The training of secondary school Mathematics teachers

The academic training of teachers for the secondary schools (Realschule and Gymnasium) is undertaken by the universities. Duration of the training is four years for teachers intending to teach the higher grades in the Realschulen (Grades 8 - 10) and six years if a teacher seeks an appointment at a Gymnasium. At West-German universities examinations are not as a rule written at the end of every academic year. The practice has been that after 8 semesters (that is, 4 years) a student may write the final examination known as the "diplom" examination. However, an intermediate examination has now been introduced at most of the universities. This intermediate examination is known as the pre-"diplom" examination and is written in two phases. A student usually writes the first phase of the pre-"diplom" examination after three or four semesters, and if he is successful, the second phase is written after a further one or two semesters. After passing the pre-"diplom" examinations the final "diplom" examinations are attempted four semesters later. The following academic qualification is the doctorate (12, p. 28). In general the "pre-diplom" examinations correspond to a Bachelor's degree and the "diplom" examination corresponds to a Master's degree. The "diplom" examination also requires a thesis over and above a written and an oral examination. The Mathematics curriculum for the "diplom" is as follows (12, p. 35):

"1. Differential and Integral Calculus
2. Analytical Geometry
3. Linear Algebra
4. Vector Analysis
5. Theory of Functions
6. Projection Geometry
7. Differential Geometry
8. Analysis
9. Topology
10. Advanced Algebra
11. Probability Theory
12. Statistics."

As regards the professional training of Mathematics teachers in West Germany it is remarkable to note that the Didactics of Mathematics receives little attention. A survey undertaken during the academic year of 1969 - 1970 revealed that the Didactics of Mathematics on an average comprises of only 2,7 per cent of the professional-mathematical training of Mathematics teachers and that many of the training courses made no provision for the Didactics of Mathematics at all (25, p. 12).

The above-mentioned shortcoming has, however, been realised by the education authorities and attempts are being made to rectify the matter. A recent development has been the establishment of national institutes of subject didactics of which the first, the Institute of Physics-Didactics came into being in 1970 under the auspices of the University of Kiel. A similar institute for the Didactics of Mathematics has been established at the University of Bieleveld (21, p. 17).

In-service training is also receiving added emphasis. As in England and Wales, teachers' centres are also being established all over the country in order to help teachers with the new syllabuses being introduced in the schools. The teachers' centres will ultimately have full-time specialists for all the subjects who will not only help the teachers but also draw the teachers into syllabus development projects. The above-mentioned institutes of subject didactics at the universities will supply these teachers' centres with research results, information and guidance.

Teaching practice is organised as a day teaching practice, that is, one morning per week is devoted to teaching practice. However, two extensive periods of four weeks each is also done, one at a school in a rural area, and one at a school in an urban area. The teachers' centres are aimed at taking care of the in-service training of the teachers. Experience gained in West Germany with the introduction of the first new Mathematics syllabuses in 1958 showed that prescribing new syllabuses, even if these were accompanied by new text-books and orientation courses for the teachers, was not a successful way of bringing about renewal (21, p. 16). It is being realised all the more that practising teachers must be at the centre of any project developing new syllabuses if any success in implementing the new syllabuses is desired. This is the same conclusion that educationalists in England and Wales arrived at, and one that must carefully be considered in South Africa.

5.6 CONCLUSION

When one considers the position of the training of Mathematics teachers in other countries, it soon becomes evident that each country has its own problems to which it has evolved its own particular solution. No other country's educational system can be applied wholesale in the South African setup nor must it be thought that solutions found to problems overseas will necessarily prove to be the answer to problems here which appear to be similar to those encountered overseas. On the other hand there are many innovations taking place overseas which educationalists in South Africa must take note of and possibly adapt to suit the situation in South Africa.

Two such innovations, among others, spring to mind immediately. The first is the impetus research in the USA has given to the system of Teaching Practice. This research has resulted in the development of mini-teaching (micro-teaching) as well as the use of video-tapes. There has been no hesitation to change the curriculum if necessary to accommodate these new Teaching Practice innovations either. The second advance that has been made, and this applies specifically to the training of Mathe= matics teachers, is the realization in Britain that there are <u>two</u> strands of training necessary, namely a practising strand in which a prospective teacher should apply his mathematical knowledge, running parallel to the traditional academic strand.

The above two innovations will receive further attention in the next chapter.

CHAPTER 6

FINDINGS AND RECOMMENDATIONS

6.1 FINDINGS

6.1.1 The main findings of this survey with respect to the training of Mathematics teachers for the primary school

a. Introduction

It will have become clear from the previous chapter that it is not only South Africa which is in the process of reorganising its educational system. There are few, if any, Western countries which are not busy adapting their educational systems to the demands of a fast changing technological society. There is the added problem of providing a meaningful education to exploding populations in each country.

The main problem experienced in most Western countries is the fact that the teaching profession does not have the necessary status to attract and keep the better qualified teachers. In America and Britain the trend now is to give more status to the teaching profession by granting degree status to teacher training courses which in the past were diploma courses. These training courses are usually reorganised and usually lengthened to deserve its degree status to a certain extent. In America most primary school teachers, for instance, are trained at universities and in 1971 72 per cent of all primary school teachers in the United States of America had a Bachelor's degree. This Bachelor's degree requires four years of study (see Paragraph 5.1.2). In England and Wales primary school teachers are still trained at teachers' training colleges and the courses are still diploma courses, but a move has already been made in the direction of added status with degree recognition being given to four-year secondary school teacher training courses at the colleges. These colleges are closely linked to universities as has already been explained (see Paragraph 5.2.1).

The same trend is discernible in the Republic of South Africa. Education is being made more meaningful for the pupils in that a greater attempt is made to cater for the pupils' interests and talents. This in turn makes greater demands on the training of teachers. To attract suitable candidates to the teaching profession, the profession has to be made more attractive.

Salaries have been increased and conditions of service have been improved. Unfortunately, here as elsewhere, in spite of these improvements more women are attracted to enter the profession. The percentage of men in the teaching profession in South Africa still continues to decrease every year, especially as far as the combined degree and professional course is concerned (39, p. 146).

Many English primary schools seldom have male teachers, the only males usually being the principal and the vice-principal It is often stated that there can be no objection to women only as far as the primary schools are concerned. This is a fallacy and a dangerous one at that. Just as much as a father is absolutely necessary in a home to ensure the proper upbringing of the children, so are male teachers necessary in the primary and the secondary schools. In fact, it has often been maintained that male teachers are even more important in the primary school than in the secondary school: Later disciplinary problems are said to have their roots in the primary school situation, where often, as has already been mentioned, the headmaster and the vice-headmaster are the only males on the staff in many city primary schools. In short, it is not only the fact that there are no male teachers to discipline the boys, but it is especially the fact that the girls have no father-figure to look up to and the ensuing interest in boys who are basically too young for such attention that leads to poor discipline. Unfortunately there is little empirical evidence to support this viewpoint, and attention must now be given to the findings in respect of the training of primary school Mathematics teachers.

b. <u>The training of primary school Mathematics teachers at the universities in the RSA</u>

On the whole, the position at the universities in the RSA as regards the training of primary school teachers has not changed drastically. Those universities which in the past never offered any courses for primary school teachers did not introduce them in 1973 with the change-over to the stipulations of the new Education Act. Those universities which previously offered such courses continued with them, simply adapting the courses to satisfy the requirements of the Criteria for the training of teachers (37). Three universities, however, are planning new courses for 1974 for the training of primary school teachers. The University of Pretoria, the University of Stellen=bosch and the University of Cape Town are to institute four-year degree courses specially for primary school teachers. This move is to be welcomed as it fills a void that has existed in the primary school teacher training for many years. It is certain, however, that should a person wish to take the degree course for primary school teachers and specialise in Mathematics, he will be required to take the usual degree courses in Mathe= matics at the university.

Students enrolling for the three-year or four-year primary teacher's diploma courses at the universities and who wish to specialise in Mathematics must take the first-year and second-year degree courses in Mathematics. The universities where this is not so are the Potchefstroom University for Christian Higher Education and the University of Stellenbosch where special Mathe= matics courses on first-year and second-year level have been devised for prospective primary school teachers.

One of the problems that does not seem to have been solved any= where is the discrepancy between didactical theory and classroom practice. The Methods Section of the mathematical courses is aimed at the practical considerations of "putting across" sections of the school syllabus to pupils in the schools. Overseas Mathematics projects like the Schools Mathematics Project (SMP) are usually also reviewed with the intent of examining their aims and analysing and comparing their syllabuses. The didactical theory covered in the Pedagogics course is usually based on a review of various didactical theories ranging from Herbart and his followers' five phases in the lesson namely preparation, presentation, assimilation, conclusion and application to Dewey and Kerschtensteiner's scheme based on the activity of the pupils and resulting in the problem-solving and self-discovery methods. Very few of the universities in the RSA attempt the modern didactical theory coming to the fore on the continent. How to integrate the didactical theory and the practical teaching in the class-room situation is seldom explained with the result that the students simply teach as they were taught or follow the methods that other teachers with whom they are placed on teaching practice have found to "work".

It must be emphasized, however, that this problem of bridging the gap between theory and practice is by no means found only at certain universities or institutions in the RSA. This is a problem that has troubled educationalists all over the world for centuries and many schools of thought have mushroomed, each offering a solution to the problem. In the RSA research has been done by all the universities in this respect and, as far as can be judged, the Faculty of Education of the University of Pretoria seems to have made an important contribution to the solution of the problem. After a very careful analysis of the didactical situation a lesson structure was arrived at which seems to satisfy even the most recent didactical, pedagogical and psychological findings both here and on the continent (see 32, 53, 54, 55). This aspect will be discussed further in Paragraph 6.3.4.

c. The training of primary school Mathematics teachers at the provincial colleges of education in the RSA

Accommodation is ample now that the secondary course students no longer enter the colleges and the senior lecturers who used to take the secondary school students are now available for the primary school teacher training programmes. This is an important aspect because the 1972 revised edition of the Criteria requires students who enrol for the three-year diploma to attain first-year university standard in at least four academic subjects (37, Par. 11.4.5). Should a student enrol for the four-year primary teacher's diploma he must attain second-year university standard in at least two academic subjects and first-year university standard in at least another four academic subjects (37, Par. 11.4.6). Every effort is being made to encourage students with the ability to take Mathematics as one of their academic subjects and furthermore to enrol for the four-year diploma. Because the lecturers with the necessary qualifications and experience are available, there have been hardly any problems during the transition period. Curricula and new syllabuses have been set up with the minimum delay and the new training courses have got under way smoothly.

As far as the content of the optional Mathematics courses is concerned, it can be said that consultation has taken place between the provincial authorities and the universities in order to devise syllabuses of the required first-year and second-year standard. In this respect the Transvaal Education Department had an advantage because it had already devised such syllabuses in co-operation with the universities a few years previously for the subjects in which the greatest shortage of teachers was experienced. Mathematics was and still is one of these subjects and it seems that the Transvaal's syllabuses for Mathematics compare favourably with first-year and second-year university standard.

Mention must be made once again of the untenable situation that has arisen in the compulsory Mathematics classes because of the complete lack of admission requirements as regards Mathematics. As has already been mentioned an estimated 20 per cent of the students have only Std. 6 Mathematics to their credit, while 30 per cent have Std. 10 Mathematics. The remaining students have passed Mathematics at Std. 8 level (see Par. 3.6). This situation gives rise to numerous problems the chief of which is the appalling drop in standards (see Par. 6.2.3 for a recommendation in this respect).

6.1.2 The main findings of this survey with respect to the training of Mathematics teachers for the secondary school

a. Academic training

The first matter of importance that must be mentioned, is that with the transfer of secondary school teachers' training from the provincial colleges of education to the universities which really got under way only in 1972, the training courses are as yet still very fluid. All the universities are still in the process of devising the most effective courses for their teacher training programmes. A revised edition of the Criteria for the Evaluation of South African Qualifications for Purposes of Em= ployment in Education, became available only in November 1972. The state of affairs as described in this report for 1973 there= fore does not necessarily reflect the 1974 position, although few major changes are expected in most cases.

The new legislation and the resulting transfer of the secondary school teachers' training to the universities has not affected the old three-year degree with one year professional training course to any considerable extent. In fact the only difference really is that the professional year is now done at university and not at college. Three universities, namely the University of Pretoria, the University of Port Elizabeth and the Rand Afrikaans University, have instituted Bachelor of Arts or Science (Education) degrees with the aim of doing away with the rigid degree followed by a diploma course division inherited from bygone days. These degrees, however, did not replace the degree and the diploma courses but are offered concurrently with them. Early indications are that students prefer the old degree plus separate diploma arrangement.

Probably the greatest problem to date has arisen with the four-year non-degree professional courses at the universities. In the past the candidates taking the equivalent course at the provincial colleges of education were preponderantly people without a matriculation exemption certificate. The universities are naturally reluctant to admit these students especially because the eight academic courses which the students are required to follow are the same courses offered to degree students irrespective of the faculty they belong to. Naturally the students without a matriculation exemption certificate find the degree courses too difficult for them and early indications are that first-year failures are very high indeed, especially in a subject like Mathematics.

As regards the tackling of the aforementioned problem the univer= sities can be divided into three main groups:

1. There are those universities who abide by their rules and regulations as laid down by their respective Senates and simply do not enrol students without the required matriculation exemption school certificate. The University of Cape Town and the University of the Witwatersrand and the University of Natal favoured this solution to the problem during 1973.

2. A second solution, followed by most of the universities, is simply to let the students without a matriculation exemption certificate enrol for the four-year non-degree diploma and to let them attempt the first-year degree courses with the other students. Some universities try to help these students by making their pass requirements less stringent. Stellenbosch University, for instance, lowered its requirements for the year mark for Mathematics III from 50 to 40 per cent for these students.

3. The third solution to the problem is that practised by the Potchefstroom University for Higher Christian Edu= cation. At this university new school orientated academic courses have been devised specifically for the students enrolled for the four-year non-degree teaching diploma. Although these new courses are recognised as being of the required first-year and second-year university standard, they are unfortunately not recognised by the Potchefstroom University or any other university for degree purposes in the event of a student who wishes to obtain his degree later by means of private study. In favour of the new courses it can for example be stated that not only are the Mathematics courses more school orientated but the students can also take the courses at a more leisurely pace so that second-year degree standard may be reached after three years of study.

b. <u>Professional training</u>

At every university in the RSA each of the three above-mentioned secondary teacher training courses has made provision for lectures on methods or didactics of Mathematics. In the one-year post-graduate course and the four-year combined degree course the lectures on the teaching methods of Mathematics are separate from the lectures on Mathematics as a subject and the courses on the methods of Mathematics teaching are usually given in the students' fourth year by lecturers of the Faculty of Education. It is imperative that all lecturers concerned with the training of Mathematics teachers should have post-graduate qualifications in both Mathematics and Education.

At a few universities the practice is to combine the Mathematics and the methods lectures in a single course which is given by a lecturer from the Department of Mathematics. The argument against such an arrangement is that lecturers from the Depart= ments of Mathematics (and other subject departments) are often specialists in their subject but have no qualifications in Education or experience of teaching in schools. It is maintained that once a subject specialist is responsible for the Mathematics Method in an integrated Mathematics and Mathematics Method Course, the Method section is involuntarily pushed into the background. This "problem of placing a didactics course in a mathematics department rather than in a department of education" was raised at the Second International Congress on Mathematical Education held at Exeter, England during September 1972 (20, p. 48). Another aspect of the didactics or methods courses which gave rise to concern is the fact that the courses seemed to be little more than an explanation of techniques to be applied to specific problems. Often a little work on overseas Mathematics projects would be included but with the possible exception of one course no trace was found of a course in the methods of Mathematics teaching based on sound didactical prin= ciples. In this respect there is a great need for more specific Methods syllabuses especially as regards the actual methods advocated by the universities. Attention should be given to the actual preparation of Mathematics lessons according to a lesson scheme. Didactical theory is usually presented to the students as part of the Pedagogics course while the practical side is left to the lecturers of each subject, as for example Mathematics. The contrast between theory and practice can be considered a serious problem in the training of teachers as has already been mentioned (see 6.1.1 b.). A possible solution recommended is to be found in Paragraph 6.3.4 of this report.

A further problem that teachers encounter at school and for which the majority of teachers' training courses offer no solution is the knowledge explosion. This knowledge explosion has led to the blind memorising of facts, manipulations and techniques by children at the cost of learning with insight. With more and more subject matter being included in the syllabu= ses, teachers' training courses will have to offer guidance to prospective teachers on how to cope with the vast syllabuses and still give the pupils the opportunity to master the subject matter with insight. In short, teachers will have to put a great deal of thought into the preparation of their lessons in order to distinguish between those elements that are really essential and those that are incidental. If prospective teachers are shown how to prepare their lessons so that the really essential core of any particular topic is mastered by the pupils with understanding then it is difficult to conceive how pupils can find Mathematics boring.

6.2 MOTIVATIONS AND RECOMMENDATIONS WITH RESPECT TO THE TRAINING OF PRIMARY SCHOOL MATHEMATICS TEACHERS

6.2.1 Introduction of a degree in primary education

a. Motivation

With regard to the new degree in primary school education as has been instituted at the universities of Cape Town, Pretoria and Stellenbosch it is the finding of this investigation that these degrees fulfil in a need that has long existed in the RSA. In the past it has happened that the promotion posts in the primary schools have been filled by staff drawn from the secondary schools. This is an undesirable practice, firstly because subject specialists are drawn away from the secondary schools where they are sorely needed, and secondly because these people have little or no training in, or experience of, primary school teaching. It is therefore welcomed that such degrees are being introduced so that the promotion posts in the primary schools can be filled by specialists from their own ranks with the necessary academic qualifications. It must further be kept in mind that the recent changes in the education system as regards differentiation and subject teaching, will make greater demands on the qualifications of primary school teachers. For this reason the introduction of a degree in primary education will fulfil a need and ensure that teachers with the necessary qualifications will be available for subject teaching in the primary schools. It therefore seems most desirable that all the other universities should strongly consider introducing the degree in primary education as well. This degree should not in any way replace the training courses for primary school teachers as at present undertaken by the provincial colleges of education.

b. Recommendation

It is recommended that all the universities in the RSA should introduce a degree in primary education for the junior and senior primary school level.

6.2.2 The necessity of spreading the mathematical courses over the full duration of the teacher's training course

a. Motivation

Especially because of the theoretical nature of Mathematics and because a teacher needs confidence in his/her mathematical ability to ensure that the pupils acquire insight into the algorithms taught it is advisable that, as far as possible, the Mathematics courses should last the duration of the teacher's training courses. For example, if an aspirant teacher is doing the three-year professional teacher's diploma at a provincial college of education, then the compulsory Mathematics/Arithmetic course should be spread over the first, second and third years of the diploma. If this is not possible, the Mathematics should be kept for the final part of the course rather than for the first part. Especially as far as primary school teachers are concerned where every teacher as a rule must teach some Arithmetic, it is essential that the teacher should have as much self-confidence as possible and up to date knowledge in teaching a subject which requires so much more than following the textbook. Should the Mathematics courses be spread over the first two years of the above-mentioned course, it is conceivable that a teacher taking up his/her first appointment will be less confident in those subjects in which he/she did no work in the previous year, that is the final year of his/her diploma.

b. Recommendation

It is recommended that Mathematics courses be spread over the full duration of the teacher's training course, or, if this is not possible, over the latter part of the teacher's training course.

6.2.3 The necessity of setting the minimum admission requirements for the primary school teacher's diploma to include Mathematics passed at Standard 10 level

a. Motivation

This survey has revealed that possibly the most serious problem experienced in the training of primary school teachers in the RSA as regards Mathematics is the heterogeneous nature of the Mathematics Method classes with respect to the students' mathematical background. With an estimated 20 per cent of the students having only Std. 6 Mathematics to their credit, and a further 40 to 50 per cent Std. 8 Mathematics, 30 per cent have passed Std. 10 Mathematics, many on the higher matriculation exemption level. Lecturers consequently are compelled to do "revision of the students' own mathematical knowledge to a level roughly equivalent to Std. 7 ......" and to teach ".... aspects of the 'New Mathematics' which the students have not done at school" (Par. 2.2.5 d).

As has already been pointed out (Par. 2.3), this level of training in Mathematics can result only in a standard of Mathematics teaching in the primary schools (where every teacher is a Mathematics teacher) which stifles all pupil interest and talent in the subject. This is possibly an important reason why the percentage of pupils taking Mathematics in the Transvaal dropped from 57,4 to 40,6 over the period 1969 - 1974 (31).

It must furthermore be pointed out that this report found no shortage of primary school teachers being experienced in any of the provinces. Standards of selection may therefore be raised without causing a shortage in the schools. The academic standard of all teacher training courses have already been raised by the stipulations of the National Education Policy Amendment Act No. 73 of 1969, and it will not be untoward to raise the admission requirement for the primary school teacher's diplomas to include a pass in Mathematics at the Std. 10 level. It must be pointed out immediately that with the recent introduction of the Functional Mathematics syllabuses to Std. 10 level, aspirant primary school teachers may have the opportunity to select a Mathematics course at school which not only aims at stimulating an interest in Mathematics but which also provides an excellent background for primary school teachers.

b. Recommendation

It is recommended that the admission requirements for all primary school teacher's diplomas be raised by stipulating that entrants must have passed Mathematics at least at the Standard 10 level

6.2.4 The necessity of research into the total primary school education system

a. Motivation

It is the opinion of the Advisory Committee for the South African Mathematics Project that it is time that a comprehensive investigation into all aspects of primary school education be launched in the RSA. Not only does the Committee feel that it is unfortunate that such an investigation has never before been undertaken, but also that it is lamentable that an untenable situation such as has obtained with respect to the admission requirements in Mathematics could exist for so long and, in fact, still exists. It is felt that similar problems could conceivably exist and which are never brought to the surface.

b. Recommendation

It is recommended that the Minister of National Education be requested to give his permission for a comprehensive investigation into all aspects of primary school education in the RSA to be undertaken.

6.3 MOTIVATIONS AND RECOMMENDATIONS WITH RESPECT TO THE TRAINING OF SECONDARY SCHOOL MATHEMATICS TEACHERS

6.3.1 Introducing a more school-orientated Mathematics course for prospective secondary school Mathematics teachers

a. Motivation

With regard to the introduction of a more school-orientated Mathematics course for students training to be Mathematics teachers this investigation wishes to draw attention to the findings of the Report on Mathematical Section of the Association of Teachers in Colleges and Departments of Education (1). The report of this Association underlines the obvious but often forgotten fact that in the training of a practising mathematician, which surely includes teachers of Mathematics, two aspects may be distinguished namely, the learning of mathematical ideas and techniques on the one hand, and the development of the ability to do Mathematics on the other. At present however, a prospec=tive teacher usually undertakes the study of Mathematics at university or college and then he starts teaching the subject without ever having had any experience of using it. The report rightly points out that there is a great difference between solving problems set as exercises on specific ideas being learnt, and problems which exist in their own right and for which no specific method of solution is even suggested. Problems set in exercises merely aim to establish learnt ideas while real mathematical activity is experienced only in exploring and solving open problems (1, p. 3). The above report further=more encourages teachers to become actively creative, for it is important that they should have the experience of personal involvement in their field (1, p. 3 - 4). The above-mentioned Association therefore recommended that there should be two streams of mathematical work included in the training of Mathematics teachers namely, the learning of new mathematical concepts, and the development of the ability to undertake mathematical investigations (1, p. 3).

In respect of the first of the two streams of mathematical training, namely the academic stream, the list of topics provided in the British report (1, p. 84) can serve as a most useful guide in devising a school-orientated Mathematics training course for the four-year non-degree secondary diploma. (The Transvaal Education Department's Mathematics course may also be consulted in this respect - see Appendix A.) This Mathe= matics Course which was specifically devised for precisely these students has already been in use for a few years and was originally considered well on first-year and second-year degree standard by a university committee.

As far as the second stream of the mathematical training is concerned namely, the development of the ability to make mathe= matical investigations, this British report describes the techniques which a practising mathematician should master as being:

(i) Formulating a problem in mathematical terms as well as inventing suitable symbols and/or diagrams.

(ii) Using existing literature - classifying the problem and so recognising its similarity to problems already solved and bodies of known theory.

(iii) Breaking down a problem by classifying different cases, ordering them and dealing with them successively.

(iv) Systematising - collecting a group of results into a logically ordered system.

(v) Axiomatising - constructing axiom systems for bodies of theory; varying axioms and investigating resulting systems (1, p. 15).

Although the above seems complicated, the British report gives a number of examples of mathematical investigations for first-year and third-year students which are invaluable. The value of this type of mathematical work also lies in presenting conclusions that have been reached in written form even if the problem has not been fully solved. Students learn how to be concise in writing down their findings and how to select and order the information.

In conclusion the following quotation is significant, especially because it links up with what was already said in the introduction to this project: "Unless a teacher can attack a new mathematical problem by himself and knows he is right because he has the ability to recognise the inner coherence of the argument he can only fall back on other people's methods and gimmicks" (1, p. 12). The introduction of a more practical stream running parallel to the academic course may hopefully receive the approval of industry which has not infrequently been critical of university mathematical courses from which students come away with little ability to use their knowledge to tackle new types of problems.

b. Recommendation

It is recommended that Mathematics courses for teachers should make provision not only for the learning of mathematical concepts but also for the development of the prospective teacher's ability to undertake mathematical investigations, and that the Report of the Mathematics Section of the Assosiation of Teachers in Colleges and Departments of Education should be consulted in this respect.

6.3.2 Mathematics courses introduced specifically for the needs of school teachers must, at least in part, be recognised for degree purposes by universities in the RSA

a. Motivation

Whereas the teaching profession is having an uphill struggle to improve its status, the introduction of any Mathematics courses fulfilling the need of teachers in the schools must necessarily be recognised for degree purposes in order to enhance the teaching profession's status. Furthermore, a person enrolling for any course does not want to feel that it is a dead-end course, a course that is recognised for teaching pur= poses only. The Criteria (37) stipulates that such courses, if offered, must be of first-year and second-year degree standard and that, as far as the training of secondary school teachers is con= cerned, must be offered by the universities. If it is felt that whereas the greater emphasis on the practical aspects of teaching Mathematics tends to detract from the academic standard of these courses, a compromise should be considered possibly using the idea of "modules". A student who has, for example, successfully com= pleted the school-orientated Mathematics courses to second-year level, could be accredited with first-year degree Mathematics and for instance two "modules" of the second-year degree course. In order to be credited with Mathematics II (degree course) the student would have to successfully complete a further two modules (sections) of the Mathematics II (degree) course. The school-orientated Mathematics courses and the degree Mathematics courses will necessarily overlap in many of the modules (sections). Once again the University of the Witwatersrand's third year Mathematics for Teachers Course could serve as an example. Not only would the introduction of such Mathematics for Teachers Courses on first-year and second-year university level contribute to the status of the teaching profession, but it would also improve the teaching of Mathematics in the secondary schools.

b. Recommendation

It is recommended that Mathematics Courses for Teachers be introduced at the institutions responsible for the training of secondary school teachers and that these Mathematics courses, at least in part, be recognised for degree purposes at all universities in the RSA.

6.3.3 The introduction of "modules" to enable students to work at a less arduous pace

a. Motivation

Considering the present situation with regard to the training of Mathematics teachers for the secondary school, one must conclude that the shortage of Mathematics teachers is going to become worse. Table 4.4 given in paragraph 4.3, showed that the four-year non-degree secondary teacher's diploma is not attracting prospective Mathematics teachers. Those students with degrees, on the other hand, are continually being enticed away from the teaching profession, especially the males.

There are two main lines of thought as regards a solution to the problem of training and keeping Mathematics teachers. The first is that the status of the teaching profession must be raised in order to attract and keep the graduates in the profession, and the second is ".... that the education systems will have to adapt themselves to a teaching force of relative lower average calibre" (30, p. 230). The solution probably lies somewhere between these two viewpoints, but when one considers that, for example, the only English university in the Transvaal will deliver only three Mathematics graduates at the end of 1974 who intend teaching while it makes no provision for the training of non-degree diploma teachers "of relative lower average calibre", then it becomes clear that if the shortage of teachers is to be relieved, more attention must be given to the training of Mathematics teachers from the ranks of those prospective teachers "of relative lower average calibre".

It must immediately be emphasised, however, that while the present crisis may be partly alleviated by paying more attention to prospective teachers of Mathematics of relatively lower academic calibre, it should be recognised that the crux of the problem is to attract the highest calibre students into the teaching profession. By "high calibre" is referred not only to academic excellence but also to qualities of character, potential for leadership and a religious upbringing.

As regards paying more attention to the training of teachers "of relative lower average calibre", it seems necessary that in the case of students without a matriculation exemption certificate enrolled for the four-year non-degree secondary teacher's diploma at other universities, the present Mathematics courses as well as the recommended courses must be so devised that a student can opt to spread the courses over a longer period of time by receiving credit for sections successfully completed. First-year level will then, for instance, be attained after two years of study. More personal attention will also have to be given to these students taking Mathematics.

In this respect the concept of "modules" as is envisaged by the University of South* Africa, and to a certain extent by the University of the Witwatersrand with its system of points for the third year Mathematics Course for Teachers, appears to be an excellent solution to the problem of spreading out the courses.

b. Recommendation

It is recommended that all secondary teacher training institutions should make provision for a system of "modules" to enable students to spread the academic course out over a longer period of time to suit their individual working tempos.

6.3.4 Bridging the gap between theory and practice

a. Motivation

In Paragraphs 6.1.1 b. and 6.1.2 b. attention was drawn to the problem of reconciling didactical theory and didactical practice in the teacher training institutions. It was emphasised that this problem occured in all the various teacher training courses from the primary school teacher's training coursesto the secondary school teacher's training courses. On the one hand various learning theories are mentioned together with didactical theories ranging from Herbart to Dewey and on the other hand various "gimmicks" are illustrated to get specific subject matter across to pupils. Very seldom is any attempt made to explain on what didactical theory such "gimmicks" and class-room practice in general are based. Prof. L. van Gelder, the eminent Dutch educationalist, maintains that class-room practice even today is based mostly on variations of Herbart's scheme as outlined by some of his followers of Preparation, Presentation, Explanation, Conclusion or Summary and Application (56, p. 51). What is not always recognised, however, is that such a class-room practice based on Herbart's presentation theory takes into account only the teacher's activity - the pupils simply sit and absorb the duly presented subject matter almost passively.

Van Gelder sees the solution to the problem of the discrepancy between didactical theory and didactical practice as lying in the thorough preparation of lessons according to a lesson scheme or lesson structure (56, p. 50). The setting up of a lesson scheme by anyone presupposes a didactical theory whether the person is aware of it or not, just as Herbart's lesson scheme presupposes the persentation theory for example. In order to devise a lesson scheme an analysis of the didactical situation must be made to highlight the absolute essentials common to all didactical situations. Attempts to produce such an analysis have been made, the most significant being that of prof. F. van der Stoep, whose analysis of the didactical situation has yielded a set of didac= tical criteria, didactical principles and basic didactical forms which he has succeeded in reconciling with current learning theories in a didactical theory and a corresponding lesson structure (54 and 55). An example of the way in which such a lesson structure is drawn up and applied to specific topics in Mathematics can be found in a publication by W.L. Oosthuizen (32, p. 50 - 74). This publication deals especially with the problem of overcrowded syllabuses and emphasises the fact that the teacher's preparation should be done along the lines of a lesson scheme which aids him in the responsible pruning of superfluous subject detail in order to concentrate on the essentials.

Without going into too many details the structure of the lesson as Van der Stoep and his colleagues visualise it is as follows (55, p. 183):

1. The form of the lesson: In his preparation a teacher must decide on -

   (a) a basic didactical form (play, example, conversation and/or task);

   (b) a methodological principle (inductive, deductive);

   (c) an arrangement of the subject matter (linear, concen= tric, chronological, etc.) and

   (d) an approach whereby the essential meaning of the new topic is brought home to the pupils whose eagerness to learn has been awakened by confronting them with the new subject matter in a problem situation.

2. The progression of the actual lesson: This consists of -

   (a) motivating the pupil to apply his pre-knowledge;

   (b) confronting the pupils with a problem connected to their experience;

   (c) exposition of the new subject matter in relation to the problem;

   (d) controlling to make sure that essence of the new subject matter has been grasped by the pupils;

   (e) allowing the pupils time to apply their new insight to related problems, and

   (f) evaluation.

The didactical theory behind this lesson scheme is based on W. Klafki's theory that not only must the meaning and structure of any subject matter be revealed to the pupil by his teacher, but also the pupil must be in a receptive mood to grasp the meaning of the basics with insight. To bring the child into an open, receptive mood is the crux of the whole lesson. It is not enough to agree with the eminent Dutch educationalist M.J. Langeveld that a child is a being who wants to be somebody and therefore, by implication, that all children by nature are interested in the topics presented to them in the class-room. Children have to have their curiosity and interest awakened. Van der Stoep maintains that effective learning occurs only when a child is confronted with a definite problem (55, p. 38): "Die temas is in sigself geen probleme nie. Tog het hulle inherent 'n baie definitiewe problematiek wat, gesien die wording= stand van die leerlinge op so 'n wyse uitgelig behoort te word in die omgang van onderwyser met leerinhoud dat dit werklik 'n betekenisvolle, opsigtelike vraag word wat die moeite werd is om beantwoord te word."

b. <u>Recommendation</u>

In view of the above-mentioned argument it is recommended that -

(a) <u>the professional side of the training of Mathematics teachers concentrate on reconciling the didactical theories they expound with the didactical practice encountered in the actual classroom situation, and</u>

(b) <u>consideration be given to the above motivation as a possible solution to the problem of effecting such a reconciliation.</u>

6.3.5 <u>Lecturers responsible for the Method (Subject Didactics) of Mathematics Teaching Course should have at the very least a Bachelor's degree in Education and an Honours degree in Mathematics</u>

a. <u>Motivation</u>

In order to facilitate the solution of bridging the gap between didactical theory and class-room practice, it is essential to ensure that those lecturers who are responsible for the Method (Subject Didactics) of Mathematics Teaching Course have the necessary qualifications in educational theory, the minimum qualification being a Bachelors' degree in Education. This will also ensure that lecturers who are Mathematics specialists do not use time set aside for the Didactics of Mathematics for further lectures in pure Mathematics: "The problem really is not what kind of mathematics should be taught, but how it is to be taught. .... The biggest wrong in the traditional mathematics was and is not the content but the methods ...." (13, p. 3). The danger of lecturers being responsible for the Method (Subject Didactics) of Mathematics and having no insight into the didactical implications involved in the teaching of the subject is that their students will teach as they themselves were taught at school: "........ algebra was presented as a bag of tricks, a collection of meaningless manipulations and geometry as a tiresome succession of theorems and 'riders'" (13, p. 3). This above motivation applies specifically to the subject didactics courses where it is considered pedagogically unsound to have subject specialists (from the Mathematics Department, for example) presenting the educational aspects of the subject concerned (Mathematics). It should not be concluded however, that lecturers responsible for the Methods Courses need not have academic qualifications in Mathematics. It is true to state that without a sound mathematical background lecturers will be unable to inspire their students in the subject. For this reason these lecturers should have at least an Honours degree in Mathe= matics too.

b. Recommendation

It is recommended that lecturers responsible for the Method (Subject Didactics) of Mathematics (as well as lecturers for all other subjects) should have a Bachelors' Degree in Education and an Honours degree in Mathematics as minimum academic qualification.

6.3.6 Teaching practice should be made more meaningful for students

a. Motivation

Teaching practice is an aspect of teacher training which research findings in the USA has pinpointed as one of the major areas requiring attention in any teacher training course (see Par. 5.1.3). Not only is the short periods of teaching practice, of two or three weeks, with a few criticism lessons evaluated by lecturers being proved inadequate, but also is the fact underlined that proper and meaningful discussion afterwards does not occur when the visiting lecturer has to fulfil a criticism lesson appointment at another venue. The practice of sending students to the schools to "observe" lessons are considered a waste of time by Americans doing research in this field, because these students do not know what to look for and seldom appreciate the significance of an experienced teacher's actions. Students who take up new teaching posts after qualifying as teachers and who have had the minimum teaching practice experience traditionally encountered, either don't stay long in the teaching profession or otherwise adopt "Survival methods" of teaching.

New techniques using video-tapes and the introduction of micro-teaching (mini-teaching) has proved to add significantly to the value of teaching practice as a preparation for teaching.

b. Recommendation

It is recommended that special consideration be given by all teacher training institutions to new developments in teaching practice techniques such as mini-teaching and the use of video-tapes to make teaching practice more dynamic and meaningful.

6.3.7 Recommendations as regards further research to promote Mathematics teaching

It is clear, however, that the recommendations offered in this report imply further research to promote Mathematics teaching and it is therefore recommended that the following aspects should receive attention as soon as possible:

a. The provision of an acceptable didactical design for the training of Mathematics teachers.

b. The function of the headmaster and the class teacher to whom students on teaching practice are assigned.

c. In-service and further training of teachers.

d. The possibility of teachers receiving promotion and salary increases within their subject teaching posts to a level equivalent to the post of a deputy head-master at least, so that subject teachers will not be lost to the class-rooms when they seek promotion to posts that are mainly administrative.

6.4 CONCLUSION

The hope is hereby expressed that the above research study will contribute not only to the improvement of the training of Mathematics teachers but also to the improvement of the training of all teachers in the RSA.

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APPENDIX A

"1.1 Naam van die sillabus: AKADEMIESE WISKUNDE.

1.2 DOEL: Die vak word aangebied aan studente wat van voornemens is om onderwysers in wiskunde te word. Hierdie kursus beoog dan om die studente met die nodige akademiese agtergrond sowel as die metodologiese toe te rus om wiskunde suksesvol aan die middelbare skool te onderrig.

1.3 TYD BESKIKBAAR VIR DIE VAK:

1.3.1 Totale aantal lesingperiodes beskikbaar.
Eerste studiejaar: 4
Tweede studiejaar: 5
Derde studiejaar: 20
Vierde studiejaar: 18

1.3.2 Aantal lesingperiodes per week.
Eerste studiejaar: 4
Tweede studiejaar: 5
Derde studiejaar: 12
Vierde studiejaar: 12

1.3.3 Aantal selfstandige studieperiodes per week.
Eerste studiejaar: 0
Tweede studiejaar: 0
Derde studiejaar: 8
Vierde studiejaar: 8

1.3.4 Die metodiek van die vak sal slegs in die derde en vierde studiejare of slegs in die vierde studiejaar aangebied word; plus minus 4 periodes word hiervoor aanbeveel.

1.4 BENADERING

Die inhoud van die sillabus moet formeel in die lesinglokaal behandel word. Studente moet genoegsame oefeninge deurwerk om sodoende werklik vertroud te raak met die stof. Die selfstudie periodes sal hoofsaaklik deur hierdie werkopdragte in beslag geneem word.

1.5 **INHOUD VAN DIE SILLABUS VIR:-**

1.5.1 **Eerste studiejaar**

1.5.1.1 **Algebra**

1.5.1.1.1 **Versamelings**

1.5.1.1.1.1. Die begrip versameling.

1.5.1.1.1.2 Elemente van 'n versameling.

1.5.1.1.1.3 Notasie:

Die gebruik van krulhakies om 'n versameling te omskryf. Is 'n element van óf is nie 'n element van 'n versameling nie.

1.5.1.1.1.4 Basiese begrippe.

1.5.1.1.1.4.1 Eindige- en oneindige versamelings.

1.5.1.1.1.4.2 Gelyke versamelings.

1.5.1.1.1.4.3 Ekwivalente versamelings:

Een-eenduidige ooreenkoms.
Kardinale getal van 'n versameling.
Gelyke versamelings is ekwivalent; ekwivalente versamelings is nie noodwendig gelyk nie.

1.5.1.1.1.4.4 Die leë versameling.

1.5.1.1.1.4.5 Deelversamelings:

Deelversameling en egte deelversameling. 'n Versameling is 'n deelversameling van homself.
Die leë versameling is 'n deelversameling van enige versameling.
Bepaling van die aantal deelversamelings van 'n versameling.
Voorwaarde vir die gelykheid van twee versame= lings.
Ekwivalensie tussen oneindige versamelings en deelversamelings van hulself.

1.5.1.1.1.4.6 Omvattende versameling en komplement van 'n ver= sameling.

1.5.1.1.1.4.7 Disjunkte versamelings.

1.5.1.1.1.5 Venn-diagramme.

1.5.1.1.1.6 Bewerkings met versamelings: Deursnee, ver= eniging en verskil.

1.5.1.1.1.7 Die volgende beginsels:

Kommutatiewe eienskap.
Assosiatiewe eienskap.
Distributiewe eienskap.
Identiteitswette.
Komplementwette.

1.5.1.1.2 Uitbreiding van die getalbegrip.

1.5.1.1.2.1 Inleidende begrippe:

'n Binêre bewerking.
Geslotenheid vir 'n bewerking.
Kommutatiewe eienskap vir 'n bewerking.
Assosiatiewe eienskap vir 'n bewerking.
Die identiteitselement vir 'n bewerking.
Die inverse element en inverse bewerkings.
Distributiewe eienskap van een bewerking oor 'n ander.

1.5.1.1.2.2 Die versameling natuurlike getalle.

1.5.1.1.2.2.1 Die natuurlike getal as gemeenskaplike eien= skap van ekwivalente eindige versamelings.

1.5.1.1.2.2.2 Grafiese voorstelling van die natuurlike getalle op die getallyn.

1.5.1.1.2.2.3 Refleksiewe eienskap, Simmetrie eienskap en Transitiewe eienskap.

1.5.1.1.2.2.4 Bewerkings in hierdie versameling met klem op:

Optel en aftrek beide kante.
Kanselleringswette.

1.5.1.1.2.3 Die versameling heelgetalle.

1.5.1.1.2.3.1 Die uitbreiding van getalbegrip van heelgetalle aan die hand van 'n geordende natuurlike getalle= paar (a, b) of intuïtief.

1.5.1.1.2.3.2 Grafiese voorstelling van heelgetalle op die getallyn. Rangorde in versameling heelgetalle.

1.5.1.1.2.3.3 Refleksiewe eienskap.

Simmetrie eienskap en Transitiewe eienskap.

1.5.1.1.2.3.4 Bewerkings in hierdie versameling met klem op:

Geslotenheid.
Kommutatiewe eienskap.
Assosiatiewe eienskap.
Identiteitselemente.
Inverse elemente.
Distributiewe eienskap van 'n bewerking oor 'n ander.

1.5.1.1.2.3.5 Tekenreëls by optelling en vermenigvuldiging.

1.5.1.1.2.4 Die versameling rasionale getalle.

1.5.1.1.2.4.1 Die rasionale getal $\frac{p}{q}$, $q \neq 0$ waar p en q heelgetalle is.

1.5.1.1.2.4.2 Refleksiewe eienskap,
Simmetrie eienskap en
Transitiewe eienskap.

1.5.1.1.2.4.3 Bewerkings in hierdie versameling met klem op:

Geslotenheid.
Kommutatiewe eienskap.
Assosiatiewe eienskap.
Identiteitselemente.
Inverse elemente.
Distributiewe eienskap van 'n bewerking oor 'n ander.

1.5.1.1.2.4.4 Rangorde in die versameling rasionale getalle.

1.5.1.1.2.4.5 Digtheid van die versameling rasionale getalle.

1.5.1.1.2.4.6 Grafiese voorstelling van die rasionale getalle op die getallyn.

1.5.1.1.2.5 Die versameling reële getalle.

1.5.1.1.2.5.1 Die irrasionale getal; voorbeelde.

1.5.1.1.2.5.2 Die versameling reële getalle.

1.5.1.1.2.5.3 Gelykheid van reële getalle:

Refleksiewe eienskap.
Simmetrie eienskap.
Transitiewe eienskap.
Optel en vermenigvuldig.

1.5.1.1.2.5.4 Bewerkings in die versameling met klem op:

Geslotenheid.
Kommutatiewe eienskap.
Assosiatiewe eienskap.
Identiteitselemente.
Inverse elemente.
Distributiewe eienskap van 'n bewerking oor 'n ander.

1.5.1.1.2.5.5 Grafiese voorstelling van reële getalle.

1.5.1.1.2.6 Komplekse getalle.

1.5.1.1.2.6.1 Die versameling komplekse getalle.

1.5.1.1.2.6.2 Definisie van i met die eienskap $i^2 = -1$.

1.5.1.1.2.6.3 Die komplekse getal a + bi, waar a en b reële getalle is. Suiwer imaginêre getalle waar $a = 0$ en $b \neq 0$.

1.5.1.1.2.6.4 Afbeelding van komplekse getalle op die getal= vlak.

1.5.1.1.2.6.5 Definisies vir

gelykheid;
optel; en
vermenigvuldig van komplekse getalle.

1.5.1.1.2.6.6 Die toegevoegde van 'n komplekse getal.

1.5.1.1.2.6.7 Eenvoudige toepassings soos:

Ontbind $a^2 + b^2$ in faktore.
Bepaal die oplossingsversameling van $\{x/x^3 + 1 = 0\}$.

1.5.1.1.3 **Getalsinne.**

1.5.1.1.3.1 Begrippe: Bewerings, oop sinne, veranderlike en plekhouer.

1.5.1.1.3.2 Oplossingsversameling van 'n oop sin met be= trekking tot gelykhede en ongelykhede met een veranderlike.

1.5.1.1.3.3 Versamelings - keurder notasie.

1.5.1.1.3.4 Grafieke van oplossingsversamelings. Intervalle - oop en geslote.

1.5.1.1.3.5 Soorte sinne:

Identiteite.
Ongelykhede - absoluut en voorwaardelik.

1.5.1.1.4 **Geordende pare, relasies en funksies.**

1.5.1.1.4.1 Geordende pare.

Oplossingsversamelings van oop sinne (verge= lykings en ongelykhede) met twee veranderlikes.

Die begrip "geordende paar".

Kartesiese- of kruis- produkte.

Grafieke van versamelings geordende pare.

Die kartesiese vlak.

Grafieke van sinne met twee veranderlikes. (Vergelykings en ongelykhede).

1.5.1.1.4.2 Relasie.

Die begrip "binêre relasie".

Relasies gesien as versamelings geordende pare en as deelversamelings van Kartesiese produkte.

Definisie- en waarde-versameling.

Die begrip "afbeelding".

Eienskappe van relasies: refleksief, simmetries, transitief.

Ekwivalensie relasies en partisies.

1.5.1.1.4.3 Funksies.

Die funksie begrip - relasie met eenduidige afbeelding.

Beeldgetal.

Funksionele notasie.

Gebruik van grafieke om vas te stel of 'n relasie 'n funksie is.

Die omgekeerde (converse) van 'n funksie.

Inverse funksies.

Funksie van 'n funksie.

1.5.1.1.5 <u>Die Resstelling.</u>

1.5.1.1.5.1 Die resstelling: As 'n veelterm $P_n(x)$ deur $x - r$ gedeel word, is die res gelyk aan $P_n(r)$.

1.5.1.1.5.2 Die Faktorstelling en omgekeerde: As r 'n wortel van die vergelyking $P_n(x) = 0$ is, is $x - r$ 'n faktor van die veelterm $P_n(x)$. As $x - r$ 'n faktor is van $P_n(x)$, is r 'n wortel van die vergelyking $P_n(x) = 0$

1.5.1.1.6 <u>Teorie van vergelykings (Kwadraties en rasionale funksies met assimptote) en grafieke.</u>

1.5.1.1.6.1 Teorie van vierkantsvergelykings.

Bepaling van die wortels.
Aard van die wortels.
Diskriminant.
Som en produk van die wortels.
Bepaling van die assimptote van 'n rasionale funksie.

1.5.1.1.6.2 Grafieke.

1.5.1.1.6.2.1 'n Funksie f in R, die versameling reële getalle, is 'n deelversameling van R X R sodanig dat as $(a,b),\ (a,c) \in f$ dan is $b = c$.

1.5.1.1.6.2.2 Die grafiek van die funksie f is die versameling punte in die reële plat vlak met die koördinate die elemente van f.

1.5.1.1.6.2.3 'n Studie van die volgende grafieke deur bepaling van: die afsnitte op die asse, definisie en waarde gebied, funksie waardes vir x groot (positief en negatief) en asimptote deur inspek= sie en/of deel.

$\{(x,y)/y = ax + b\}$;

$\{(x,y)/y = ax^2 + bx + c\}$ ondersoek die gevalle $b^2 - 4ac \gtrless 0$;

$\{(x,y)/y = ax^3 + bx^2 + cx + d\}$;

$\left\{(x,y)/y = \frac{ax^2+bx+c}{dx^2+cx+f}\right\}$ ondersoek ook gevalle

Soos:

$\left\{(x,y)/y = \frac{2x^2}{x}\right\}$, $\left\{(x,y)/y = \frac{bx-c}{cx+f}\right\}$ ens;

$\{(x,y)/y = x\}$.

1.5.1.2 <u>Goniometrie</u>

1.5.1.2.1 Hoekmaat (draaiing): Grade (positiewe of nega= tiewe hoeke).

Goniometriese verhoudings gedefinieer in terme van die koördinate van die merkpunt van 'n hoek op 'n sirkel met middelpunt (0,0).

Die verhoudings van negatiewe hoeke.

Grafiese voorstelling van goniometriese funksies.

1.5.1.2.2 Die goniometriese verhoudings van die hoeke $(90° \pm \theta)$, $(180° \pm \theta)$, en in die algemeen: $(n \times 90° \pm \theta)$ waar n ewe of onewe is.

1.5.1.2.2.2.1 Die verhoudings van 30°, 45°, 60° en die limiete van die verhoudings as $\theta \rightarrow 0°$ en $\theta \rightarrow 90°$.

1.5.1.2.2.2.2 Die herleiding van die goniometriese verhouding van enige hoek na die verhouding van 'n hoek:

kleiner as 90°
kleiner as 45°

1.5.1.2.3 Die identiteit: $\cos^2\theta + \sin^2\theta = 1$, en ander identiteite wat hieruit volg.

1.5.1.2.4 Formules vir cos (A–B), cos (A+B), sin (A $\pm$ B), tan (A $\pm$ B). Slegs 'n bewys vir cos (A–B) is nodig – die ander word hieruit afgelei.

Toepassing van bogenoemde formules om die ver=houdings van dubbelhoeke en halwe hoeke af te lei.

Somme van goniometriese verhoudings geskryf as produkte, en omgekeerd, bv. $\sin S + \sin T = 2\sin\frac{S+T}{2}\cos\frac{S-T}{2}$ en $2\sin A\cos B = \sin(A+B) + \sin(A-B)$, ens.
Ander eenvoudige toepassings.
Oplossings van goniometriese vergelykings.
Identiteite.

1.5.1.2.5 Hoekmaat: radiale en omsetting.
Afleiding van die ongelykheid:

$1 > \frac{\sin x}{x} > \cos x$, waar x 'n klein hoek is, en gevolglik die limiete:

$\lim_{x\to 0}\frac{\sin x}{x}$ en $\lim_{x\to 0}\frac{\tan x}{x}$

1.5.1.2.6 Die inverse van die goniometriese funksies.

1.5.1.2.6.1 Definisie van die $\sin^{-1}x$ (bg sin x of arc sin x).

1.5.1.2.6.2 Hoofwaarde van $\sin^{-1}x = \{y/\sin y = x; -\frac{\pi}{2} \leq y \leq \frac{\pi}{2}\}$ e.a., of bg $\sin x = \sin^{-1}x \cap -\left[\frac{\pi}{2}, \frac{\pi}{2}\right]$, waar $\sin^{-1}x$ die inverse relasie is, met oneindig baie oplossings, en bg sin x die hoofwaarde.

1.5.1.2.6.3 Grafiese voorstelling van die inverse funksies.

1.5.1.2.6.4 Toepassing.

Berekening van uitdrukkings soos:
$\sin(\arcsin(\frac{1}{2}) \arccos(-\frac{1}{2}))$.
Oplossing van vergelykings soos:
$\arcsin x = \arccos(\frac{\sqrt{3}}{2} + x)$

1.5.2 <u>Tweede studiejaar</u>

1.5.2.1 <u>Algebra</u>

1.5.2.1.1 <u>Eksponente en wortelvorme</u>

1.5.2.1.1.1 b^n, waar b 'n reële getal is en $n \in Z^+$ groot 2, die versameling positiewe heelgetalle.

Die begrippe eksponent, grondtal en mag.

Bewys van die eksponentwette (en afleidings) deur die metode van Wiskundige Induksie.

1.5.2.1.1.2 b^p, waar b 'n reële getal is en $p \in Z$, die ver=sameling heelgetalle.

Definisies vir b^0 en b^{-n} (Uitsluiting van 0^0 en 0^{-n}).

Bewyse vir die geldigheid van die eksponentwette (en afleidings) met heelgetalle as eksponente.

1.5.2.1.1.3 b^r, maar $b \in R$, die versameling reële getalle, en $r \in Q$, die versameling rasionale getalle.

Definisies vir $b^{\frac{1}{p}}$ en $b^{\frac{p}{q}}$

Bewyse vir die geldigheid van die eksponentwette (en afleidings) met rasionale eksponente.

Definisies vir 0^r.

1.5.2.1.1.4 Wortelvorme.
Vereenvoudiging.
Oplos van vergelykings wat wortels bevat.

1.5.2.1.1.5 b^k, waar $b \in R$ en $k \in R$, die versameling reële getalle.

Aanvaarding van die geldigheid van die eksponent=
wette met reële eksponente op grond van die kon=
tinuïteit van
$\{(x,y)/y = b^x,\ b \in R,\ x \in R\}$

1.5.2.1.2 <u>Logaritmes.</u>

1.5.2.1.2.1 Definisie van 'n logaritme.

1.5.2.1.2.2 Die grafiek en eienskappe van die funksie
$\{(x,y)/y = a^x,\ a > 0,\ a \neq 1,\ x \in R\}$

1.5.2.1.2.3 Die grafiek en eienskappe van die funksie
$\{(x,y)/y = \log_a x,\ a > 0,\ a \neq 1,\ x > 0,\ x \in R\}$

1.5.2.1.2.4 Eienskappe van Logaritmes:

$\log_a mn = \log_a m + \log_a n;$

$\log_a\left(\frac{m}{n}\right) = \log_a m - \log_a n;$

$\log_a m^r = r\log_a m;$

$\log_a m = \frac{\log_b m}{\log_b a}$; op voorwaarde dat a,b,m,n,r $\in R$; m.n.a.b positief is;
$a \neq 1,\ b \neq 1.$

1.5.2.1.2.5 Logaritmes tot die basis 10.

1.5.2.1.2.6 Die toepassing van die eienskappe van logaritmes by die rekenliniaal.

1.5.2.1.2.7 Die oplos van eksponensiële en logaritmiese vergelykings.

1.5.2.1.3 <u>Permutasies en Kombinasies.</u>

1.5.2.1.3.1 Definisie van 'n kombinasie en 'n permutasie
Eenvoudige voorbeelde om die verskil in begrip aan te toon.

1.5.2.1.3.2 Betekenis van die notasie: n! ('n fakulteit).

1.5.2.1.3.3 Permutasies.

1.5.2.1.3.3.1 Afdeling dat:
${}^nP_r = \frac{n!}{(n-r)!}$ en ${}^nP_n = n!$ (Sonder herhaling.)"

$^nP_r = n^r$ en $^nP_n = n^n$. (Met herhaling.)

1.5.2.1.3.3.2 Die aantal permutasies van die letters van 'n woord sonder herhalings en met herhalings.

1.5.2.1.3.4 Kombinasies.

Afleiding van $^nC_r = \frac{n!}{r!\,(n-r)!}$ uit ^nP_r

en gevolglik dat $^nC_r = {}^nC_{n-r}$ en $^nC_r + {}^nC_{r-1}$

$= {}^{n+1}C_r$

Die betekenis van 0!

1.5.2.1.4 Wiskundige induksie

1.5.2.1.5 Die Binomiaalstelling.

1.5.2.1.5.1 Die binomiaalstelling deur volledige induksie waar die eksponente positiewe heelgetalle is.

1.5.2.1.5.2 Toepassings;

Die algemene term in die ontwikkeling en ander afleidings.

Die ontwikkeling van $(1+x)^n$

Rekenkundige benaderings deur gebruik te maak van die binomiaalstelling.

Uitbreiding van die binomiaalstelling tot voorbeelde soos $(a + b + c)^n$.

Grootste koëffisiënte in die uitbreiding.

Numeries grootste term.

$C_0 + C_1 + C_2 + \ldots\ldots\ldots\ldots\ldots + C_n = 2^n$ waar

$C_r = {}^nC_r$.

Die waarde van $(C_0)^2 + (C_1)^2 + (C_2)^2 + \ldots\ldots\ldots + (C_n)^2$.

1.5.2.1.6 Rye en Reekse:

1.5.2.1.6.1 Die verskil tussen die begrippe ry en reeks.

1.5.2.1.6.2 Die rekenkundige rye en reekse.

Die formule vir die n-de term.

Die rekenkundige gemiddelde.

Die som Sn tot n terme.

1.5.2.1.6.3 Die meetkundige rye en reekse.

Die n-de term van 'n meetkundige ry.

Die meetkundige gemiddelde.

Die som Sn van die eerste n terme.

Konvergensie en divergensie van oneindige meet=kundige reekse.

1.5.2.1.6.4 Die harmoniese reekse en die harmoniese gemiddel=de.

1.5.2.1.6.5 Die volgende eindige reekse:

Rekenkundige-meetkundige reeks;

$\sum r^2$;

$\sum r^3$.

1.5.2.2 ANALITIESE MEETKUNDE.

L.W. Die begrip lokus gedefinieer as 'n deel=versameling van die Kartesiese vlak R X R, behoort in hierdie afdeling deurgaans die uitgangspunt te wees. Bewyse van die formules word vereis.

1.5.2.2.1 Inleidend.

1.5.2.2.1.1 Die begrip getallyn.

1.5.2.2.1.1 Koördinate.

Een-dimensioneel.

Twee-dimensioneel.

1.5.2.2.2 Punt, lengte, oppervlakte.

Lengte van 'n gegewe lynstuk; afstand vanaf 'n gegewe punt na die oorsprong.

Koördinate van die punt wat 'n gegewe lynstuk in 'n gegewe verhouding verdeel. Afleiding van die koördinate vir die middelpunt van 'n gegewe lynstuk.

Die oppervlakte van 'n driehoek met gegewe hoek=punte.

1.5.2.2.3 Die reguit lyn: helling, gradiënt, vergelyking.

1.5.2.2.4 Die vergelykings van:

die x-as; die y-as;

reguit lyne ewewydig aan die koördinaat-asse;

die reguit lyn deur die oorsprong met gegewe gradiënt; die reguit lyn deur 'n gegewe punt met 'n gegewe gradiënt; die reguit lyn deur twee gegewe punte;

die reguit lyn met snypunt (a, o) en (o, b) met x- en y-asse respektiewelik:

$$\frac{x}{a} + \frac{y}{b} = 1;$$

die reguit lyn in die normaalvorm;

$x \cos\theta + y \sin\theta = p$; die reguit lyn in para=metriese vorm

$$\frac{x-x_1}{\cos d} = \frac{y-y_1}{\sin d} = r.$$

1.5.2.2.5 Die voorwaarde dat drie gegewe punte op 'n reguit lyn sal hê.

1.5.2.2.6 Punt en reguit lyn.

Ligging van 'n punt t.o.v. 'n reguit lyn.

Ligging van 'n punt t.o.v. twee reguit lyne.

Die vergelyking van 'n reguitlyn deur die snypunt van twee gegewe reguit lyne m.b.v. die λ (prinsiep.

Die afstand vanaf 'n gegewe punt tot 'n gegewe lyn.

1.5.2.2.7 Hoeke:

Die hoek tussen twee gegewe reguit lyne uitgedruk in terme van hulle hellings.

Voorwaardes vir: ewewydigheid van twee reguit lyne; ortoganaliteit van twee reguit lyne.

Die vergelyking van die halveerlyne van die hoeke tussen twee gegewe reguit lyne.

1.5.2.2.8 Die Sirkel.

Die vergelyking van 'n sirkel met (a) middelpunt (o,o) en straal r (b) middelpunt (p,q) en straal r.

Die straal en middelpunt van die sirkel;
$x^2 + y^2 + 2gx + 2fy + c = 0$.

Die vergelyking van 'n sirkel as die eindpunte van 'n middellyn gegee is.
Die vergelyking van 'n sirkel deur drie gegewe punte.

1.5.3 DERDE STUDIEJAAR

1.5.3.1 Lineêre Algebra

1.5.3.1.1 Vektore:

Die benadering is deurgaans algebraïes maar dit word verwag dat 'n meetkundige voorstelling van die gegewens, waar moontlik gegee sal word.

1.5.3.1.1.1 Definisie van 'n vektor as 'n geordende ry reële getalle.

Die nulvektor.
Norm van 'n vektor en eienskappe van die norm.
Gelykheid van twee vektore.
Eenvektore.
Die eenheidsvektor.
Meetkundige voorstelling van twee- en drie-dimensionale vektore.

1.5.3.1.1.2 Optelling van vektore.

Bewerkingsreëls: Geslotenheid

$$\underline{a} + \underline{b} = \underline{b} + \underline{a}$$

$$\underline{a} + (\underline{b} + \underline{c}) = (\underline{a} + \underline{b}) + \underline{c}$$

Identiteitselement
Inverse element.

Meetkundige interpretasie van optelling van vektore in twee en drie dimensies.

1.5.3.1.1.3 Vermenigvuldiging van 'n vektor met 'n skalar.

Bewerkingsreëls:

$$p(\underline{a} + \underline{b}) = p\underline{a} + p\underline{b}$$

$$(p + q)\,\underline{a} = p\underline{a} + q\underline{a}$$

$$(pq)\,\underline{a} = p(q\underline{a})$$

Aftrekking van vektore.

1.5.3.1.1.4 Die skalarproduk (inwendige produk) van twee vektore.
Bewerkingsreëls:

$$\underline{a}.\ (\underline{b} + \underline{c}) = \underline{a}.\underline{b} + \underline{a}.\underline{c}$$

$$\underline{a}.\ (k\underline{b}) = k\ (\underline{a}.\underline{b})$$

1.5.3.1.1.5 Komponente van 'n vektor.

Die skryfwyse $\underline{a} = \underline{a_1}\ i + \underline{a_2}\ j$ vir $a = (a_1, a_2)$

en $\underline{a} = \underline{a_1}\ i + \underline{a_2}\ j + \underline{a_3 k}$

vir $\underline{a} = (\underline{a_1}, \underline{a_2}, \underline{a_3})$

Die posisievektor van 'n punt.

1.5.3.1.1.6 Definisie en begrip van 'n lineêre kombinasie van vektore en van die lineêre afhanklikheid van vektore.

1.5.3.1.1.6.1 Stellings:

1.5.3.1.1.6.1.1 'n Aantal vektore is lineêr afhanklik as en alleen as minstens een van die vektore lineêr afhanklik is van die res.

1.5.3.1.1.6.1.2 Twee drie-dimensionale vektore is lineêr afhanklik as en alleen as die twee vektore in 'n reguit lyn lê.

1.5.3.1.1.6.1.3 Drie drie-dimensionale vektore is lineêr afhanklik as en alleen as die drie vektore in dieselfde plat vlak lê.

1.5.3.1.1.6.1.4 Vier drie-dimensionale vektore in die ruimte is altyd lineêr afhanklik.

1.5.3.1.1.6.2 Toepassings in drie dimensies.
Afstand tussen twee punte.
Hoek tussen twee vektore.
Vektor loodreg op twee gegewe vektore.

1.5.3.1.2 <u>Matrikse.</u>

1.5.3.1.2.1 Terminologie.

Matriks.
Elemente van 'n matriks.
Rye en kolomme.
Orde.
Nulmatriks.

1.5.3.1.2.2 Skryfwyse

Maniere om 'n matriks aan te dui.
Maniere om elemente aan te dui.

1.5.3.1.2.3 Gelykheid van matrikse.

1.5.3.1.2.4 Die som van matrikse van dieselfde orde.

Bewerkingsreëls: $A + B = B + A$

$(A + B) + C = A + (B + C)$

Die additiewe identiteitselement.
Die additiewe inverse.

1.5.3.1.2.5 Vermenigvuldiging van 'n matriks met 'n skalar.

Bewerkingsreëls: $rA = Ar$

$rA + sA = (r + s) A$

$(rs) A = r (sA)$

$r (A + B) = r A + r B$

1.5.3.1.2.6 Die verskil tussen twee matrikse van dieselfde orde.

1.5.3.1.2 7 Vermenigvuldiging van een matriks met 'n ander matriks.

Bewerkingsreëls (indien bewerkings gedefinieer is):

$(AB)C = A(BC)$

Die kommutatiewe wet is nie noodwendig altyd waar nie:
Multiplikatiewe identiteitselement.
Magte van matrikse.

1.5.3.1.2.8 Die inverse van 'n matriks.
Singuliere en nie-singuliere matrikse.
Bepaling van die inverse van 'n 2 X 2 matriks (Sonder determinant-notasie)

1.5.3.1.2.9 Verdere eienskappe van matrikse:

Getransponeerde matriks
Skalarmatriks
Diagonaalmatriks
Ryvektore en kolomvektore van 'n matriks

1.5.3.1.3 Determinante van die tweede en derde orde.

1.5.3.1.3.1 Determinante van die tweede orde.

Uitdrukkings van die vorm $a_1 b_2 - a_2 b_1$

Voorbeelde waar uitdrukkings van hierdie vorm aangetref word:

(i) by die oplos van twee gelyktydige ver= gelykings in twee onbekendes.

(ii) by die bepaling van die inverse van 'n matriks.

(iii) die oppervlakte van 'n driehoek met hoek= punte $(0,0)$, (a_1, b_1) en $a_2, b_2)$ ens.

Die determinant–notasie en bewerkingsreëls.

1.5.3.1.3.2 Determinante van die derde orde.
Uitdrukkings van die vorm

$$a_1b_2c_3 - a_1b_3c_2 + a_2b_3c_1 - a_2b_1c_3 + a_3b_1c_2$$

$$- a_3b_2c_1.$$

Determinant–notasie.
Ontwikkeling volgens rye of kolomme.
Ontwikkeling volgens die silindermetode.

1.5.3.1.3.3 Eienskappe van determinante.

1.5.3.1.3.3.1 $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{vmatrix}$ ens.

1.5.3.1.3.3.2 $\begin{vmatrix} a_1 & a_2 & a_3 \\ c_1 & c_2 & c_3 \\ b_1 & b_2 & b_3 \end{vmatrix} = - \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$ ens.

1.5.3.1.3.3.3 $\begin{vmatrix} a_1 & a_2 & a_3 \\ a_1 & a_2 & a_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = 0$ ens.

1.5.3.1.3.3.4 $\begin{vmatrix} k\,a_1 & k\,a_2 & k\,a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = k \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix}$ ens.

1.5.3.1.3.3.5 $\begin{vmatrix} 0 & 0 & 0 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = 0$ ens.

1.5.3.1.3.3.6 $\begin{vmatrix} a_1 & a_2 + kd_1 & a_3 \\ b_1 & b_2 + kd_2 & b_3 \\ c_1 & c_2 + kd_3 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} + k \begin{vmatrix} a_1 & d_1 & a_3 \\ b_1 & d_2 & b_3 \\ c_1 & d_3 & c_3 \end{vmatrix}$

ens.

1.5.3.1.3.3.7 $\begin{vmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{vmatrix} = \begin{vmatrix} a_1 & a_2 & a_3 + k a_1 \\ b_1 & b_2 & b_3 + k a_2 \\ c_1 & c_2 & c_3 + k a_3 \end{vmatrix}$ ens.

Toepassing van die genoemde eienskappe om die waarde van 'n determinant te bereken.

1.5.3.1.3.4 Die lineêre wisselfunksie $F(v_1; \; v_2)$ wat die oppervlakte van 'n parallelogram met aangrensende sye v_1 en v_2 gee.

1.5.3.1.4 <u>Die oplossing van lineêre vergelykings.</u>

1.5.3.1.4.1 Die oplossing van twee lineêre vergelykings in twee onbekendes deur gebruik te maak van matrikse en determinante.

Die reël van Cramér.

Meetkundige voorstelling van die verskillende moontlikhede:

(i) $\mathcal{D} \neq 0$

(ii) $\mathcal{D} = \mathcal{D}x - dy = 0$

(iii) $\mathcal{D} = 0$ en $\mathcal{D}x$ en $\mathcal{D}y$ nie albei nul.

1.5.3.1.4.2 Stelsels homogene vergelykings.
Nodige en voldoende voorwaarde vir 'n nie-triviale oplossing.

1.5.3.1.4.3 Stelsels lineêre vergelykings in drie onbekendes.

Die reël van Cramér en die toepassing om stelsels homogene vergelykings op te los.
Gevalle waar $\mathcal{D} = 0$.
Meetkundige voorstelling van die verskillende moontlikhede.

1.5.3.1.5 Parsieelbreuke.

Die ontbinding van 'n rasionale breuk (kwosiënt van twee veelterme) in parsieelbreuke.

1.5.3.1.5.1 Die teller van laer graad as die noemer. Die volgende gevalle kom voor:

(i) Die faktore van die noemer is almal lineêr en verskillend.

(ii) Die faktore van die noemer is almal lineêr, sommige dieselfde.

(iii) Die noemer bevat kwadratiese faktore, almal verskillend.

(iv) Die noemer bevat kwadratiese faktore, sommige dieselfde.

1.5.3.1.5.2 Die geval waar die teller van hoër graad is as die noemer.

Opmerking

(i) Elke rasionale breuk behoort tot een van die genoemde gevalle.

(ii) Wys op teenstrydigheid wat voorkom indien die graad van die teller van een van die parsieelbreuke verkeerd gekies word.
Eksistensiestellings word nie bewys.

(iii) Voorbeelde word beperk tot eenvoudiger gevalle.

1.5.3.2 ANALISE

1.5.3.2.1 Inleiding:

Historiese agtergrond: oppervlaktes begrens deur krommes snelheidsprobleme e.s.m.

1.5.3.2.2 Funksies, Limiete en Kontinuïteit.

1.5.3.2.2.1 Hersiening van die funksiebegrip, inverse funksies en funksie van 'n funksie.

1.5.3.2.2.2 Intuïtiewe behandeling van die limietbegrip – die limiet van 'n ry, die limiet van 'n funksie in 'n punt.

1.5.3.2.2.3 Formele definisie van 'n limiet – stellings oor limiete.

1.5.3.2.2.4 Kontinuïteit van 'n funksie in 'n punt en kontinuïteit oor 'n interval.

1.5.3.2.3 <u>Differensiaalrekene:</u>

1.5.3.2.3.1 Die afgeleide van 'n funksie in 'n punt en die afgeleide funksie; differensiaal koëffisiënt.

1.5.3.2.3.1 Differensiasie uit eerste beginsels van een=voudige algebraïese funksies; kontinuïteit as 'n nodige voorwaarde vir differensieerbaar=heid.

1.5.3.2.3.3 Die standaardstellins oor die differensiasie van die som, verskil, produk en kwosiënt van twee funksies.

1.5.3.2.3.4 Die afgeleide van 'n inverse funksie en van 'n funksie van 'n funksie.

1.5.3.2.3.5 Bewys van $\frac{d}{dx} ax^n = anx^{n-1}$ vir

(i) n heel en

(ii) n rasionaal.

1.5.3.2.3.6 Hoër afgeleides – Reël van Leibniz.

1.5.3.2.3.7 Toepassings: stygende en dalende funksies, groeitempo draai en buigpunte, maksima en minima skets van krommes van funksies van die 2de en 3de graad.

Probleme op reglynige beweging.

1.5.3.2.4 <u>Die Middelwaarde stelling vir afgeleides</u>

1.5.3.2.4.1 Rolle se stelling (bewys nie nodig)

1.5.3.2.4.2 Die middelwaardestelling.

1.5.3.2.5 <u>Integraalrekene:</u>

1.5.3.2.5.1 Intuïtiewe behandeling van die bepaalde inte= graal as die limiet van 'n som.

1.5.3.2.5.2 Berekening van eenvoudige bepaalde integrale uit eerste beginsels.

1.5.3.2.5.3 Intuïtiewe behandeling van die fundamentale stellings

(i) As $A(x) = \int_a^x f(t)dt$ dan is $\frac{d}{dx} A(x) = f(x)$

(ii) $\int_a^b f(x)\,dx = g(b) - g(a)$ waar $g'(x) = f(x)$;

implikasies hiervan.

1.5.3.2.5.4 Onbepaalde integraal, integrand en die stel= lings:

(i) $\frac{d}{dx}\left\{\int f(x)\,dx\right\} = f(x)$

(ii) $\int kf(x)dx = k\int f(x)dx$

Indien die be= trokke integra= le bestaan.

(iii) $\int\left[f(x) + g(x)\right]dx = \int f(x)dx + \int g(x)dx$

1.5.3.2.5.5 Die formule $\int ax^n dx = \frac{ax^{n+1}}{n+1} + c$,

n rasionaal maar $n \neq -1$; integrasie van veel= terme.

1.5.3.2.5.6 Eenvoudige toepassings van bepaalde integrale by die bepaling van oppervlaktes, volumes en booglengtes; probleme i.v.m. reglynige be= weging (konstante en veranderlike versnelling) e.s.m.

1.5.3.2.6.1 Die goniometriese of sirkel-funksies.

1.5.3.2.6.1.1 Hersiening van die limiet, $\lim_{\theta \to 0} \frac{\sin\theta}{\theta}$,

θ in radiale.

1.5.3.2.6.1.2 Die afgeleide van die sinus-funksie uit eer= ste beginsels; die afgeleides van die orige sirkelfunksies.

1.5.5.2.6.1.3 Die integrale van sirkelfunksies.

1.5.3.2.6.2 Die inverse goniometriese funksies (siklome= triese funksies) se afgeleides en integrale. Dié funksies as integrale.

1.5.3.3 <u>Analitiese Meetkunde.</u>

1.5.3.3.1 <u>Die lynpaar:</u>

1.5.3.3.1.1 'n Lynpaar met die oorsprong as snypunt. Die hoek tussen die lynpaar. Die halveerlyne van die hoeke tussen die lyn= paar.

1.5.3.3.1.2 'n Lynpaar met 'n willekeurige snypunt. Die hoek tussen die lynpaar en die halveerlyne van die hoeke tussen die lynpaar m.b.v. die transformasie van die koördinate.

Die nodige voorwaarde dat $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$ 'n lynpaar voorstel.

1.5.3.3.2 <u>Die sirkel en reguit lyn</u>

1.5.3.3.2.1 Die vergelyking van 'n koord met gegewe middel= punt in 'n gegewe sirkel.

1.5.3.3.2.2 Die vergelyking van die raaklyn aan en normaal (straal) op 'n gegewe sirkel in die punt (x_1, y_1).

1.5.3.3.2.3 Die lengtes en vergelykings van raaklyne aan 'n gegewe sirkel vanaf 'n punt (x_1, y_1) buite die sirkel.

1.5.3.3.2.4 Die voorwaardes dat $y = mx + c$ die sirkel

(i) $x^2 + y^2 = r^2$

(ii) $x^2 + y^2 + 2gx + 2fy + c = 0$ sny, raak, glad nie sny en die bepaling van die raakpunte.

1.5.3.3.2.5 Die raakkoord.

1.5.3.3.2.6 Pool en poollyn. Toegevoegde punte, toege= voegde lyne en die pooldriehoek.

1.5.3.3.3 Die Kegelsnedes:

1.5.3.3.3.1 Inleiding:

(i) 'n kurwe verkry deur die snyding van 'n platvlak en 'n reghoekige sirkelvormige kegel.

(ii) die lokus begrip.

1.5.3.3.3.2 Die vergelykings van die kegelsnedes in sy eenvoudigste vorm en elementêre eienskappe van die parabool, ellips en hiperbool m.b.t. middelpunt, brandpunte, riglyne, eksentrisiteit en latus rectum.

1.5.3.3.3.3 Raaklyn en normaal. Vergelykings raakkoorde, raaklyne, normale en voorwaardes vir raak.

1.5.3.3.3.4 Pool en poollyn.

1.5.3.4 Komplekse getalle (C)

1.5.3.4.1 Aftrek en deling.

1.5.3.4.2 Eienskappe van die komplekse getalle.

1.5.3.4.3 Grafiese voorstelling van die komplekse getal in die modulus-argument vorm.

1.5.3.4.4 Die produk en kwosiënt van twee komplekse ge= talle in die modulus-argument vorm.

1.5.3.4.5 De Moivre's se stelling met toepassing.

1.5.4 VIERDE STUDIEJAAR

1.5.4.1 Algebra

1.5.4.1.1 Basiese eienskappe van die versameling heel= getalle.

1.5.4.1.1.1 Induksie

1.5.4.1.1.2 Euclidiese algoritme

1.5.4.1.1.3 G.G.D.

1.5.4.1.1.4 Kongruensies in die ring van heelgetalle.

1.5.4.1.2 <u>Groepe</u>

1.5.4.1.2.1 Definisie van 'n groep.

1.5.4.1.2.2 Voorbeelde van groepe.

1.5.4.1.2.3 Ondergroepe.

1.5.4.1.2.4 Die orde van 'n groep.

1.5.4.1.3 <u>Afbeeldings</u>

1.5.4.1.3.1 Aaneenskakeling van afbeeldings.

1.5.4.1.3.2 Homomorfie.

1.5.4.1.3.3 Isomorfie

1.5.4.1.3.4 Automorfie.

1.5.4.1.3.5 Permutasiegroepe.

1.5.4.1.4 <u>Ringe</u>

1.5.4.1.4.1 Definisie van 'n ring.

1.5.4.1.4.2 Voorbeelde van ringe.

1.5.4.1.4.3 Nuldelers in ringe.

1.5.4.1.4.4 Definisie van 'n integriteitsgebied.

1.5.4.1.5 <u>Liggame</u>

1.5.4.1.5.1 Definisie van 'n liggaam.

1.5.4.1.5.2 Voorbeelde van liggame.

1.5.4.1.6 Vektorruimtes en voorbeelde.

1.5.4.2 <u>Analise</u>

1.5.4.2.1 <u>Sekere transendente funksies:</u>

1.5.4.2.1.1 Die logaritmiese funksie gedefinieer deur die bepaalde integraal $\int_1^x \frac{1}{t}\,dt$. Die grondtal e van die natuurlike logaritmes.

1.5.4.2.1.2 Die funksie $\log_e$ en sy inverse funksie eksp_e.

Hulle afgeleides en integrale.

1.5.4.2.1.3 Afgeleide en integraal van die magsfunksies gedefinieer deur

$y = a^x$ en van sy inverse.

1.5.4.2.1.4 Die hiperboliese funksies.

1.5.4.2.1.4.1 Definisies en identiteite.

1.5.4.2.1.4.2 Inverse hiperboliese funksies.

1.5.4.2.1.4.3 Afgeleides van die hiperboliese funksies.

1.5.4.2.1.4.4 Integrale waarin hiperboliese funksies voor=kom.

1.5.4.2.1.5 Toepassings.

1.5.4.2.1.5.1 Integrasie deur transformasie van die integrand; eenvoudige toepassings.

1.5.4.2.1.5.2 Parsiële integrasie.

1.5.4.2.2 Funksies van meer as een veranderlike.

1.5.4.2.2.1 Bespreking van uitbreiding van begrippe soos eenwaardigheid, kontinuïtief na funksies van meer as een veranderlike.

1.5.4.2.2.2 Parsiële afgeleides, die totale differensiaal.

1.5.4.2.2.3 Meetkundige interpretasie.

1.5.4.2.2.4 Parsiële afgeleides van hoër orde; toepassings.

1.5.4.2.3 Rye en Reekse

1.5.4.2.3.1 Oneindige rye en reekse; toetse vir konvergen=sie en divergensie; absolute konvergensie.

1.5.4.2.3.2 Magreekse; interval van konvergensie.

1.5.4.2.3.3 Maclaurin se uitbreiding van 'n funksie as 'n reeks.

1.5.4.2.3.4 Taylor se stelling; konvergensie van die resterm.

1.5.4.2.3.5 Die reeksuitbreidings van die sirkelfunksies, eksponensiale en logaritmiese funksies.

1.5.4.2.4 Differensiaalvergelykings

1.5.4.2.4.1 Inleiding; klassifikasie van D.V.'s

1.5.4.2.4.2 Skeibare eerste orde vergelykings.

1.5.4.2.4.3 Homogene eerste orde vergelykings.

1.5.4.2.4.4 Lineêre eerste orde vergelykings.

1.5.4.2.4.5 Eenvoudige toepassings.

1.5.4.3 Analitiese Meetkunde

1.5.4.3.1 Poolkoördinate:

1.5.4.3.1.1 Koördinate.

1.5.4.3.1.2 Relasie tussen poolkoördinate en kartesiese koördinate.

1.5.4.3.1.3 Skets van grafieke in poolkoördinate.

1.5.4.3.1.4 Vergelykings van lyne en sirkels in poolkoördinate - eenvoudige gevalle.

1.5.4.3.2 Drie-dimensionele kartesiese koördinate:

1.5.4.3.2.1 Reghoekige koördinate in die ruimte en die konstruksie van figure.

1.5.4.3.2.2 Die afstand tussen twee punte.

1.5.4.3.2.3 Rigtingsgetalle en - cosinusse.

1.5.4.3.2.4 Verdelingspunt van 'n lynstuk in die ruimte.

1.5.4.3.2.5 Die hoek tussen twee lyne.

1.5.4.3.2.6 Die vergelyking van die plat vlak.

1.5.4.3.2.7 Die afstand vanaf 'n punt na die platvlak.

1.5.4.3.2.8 Die hoek tussen twee vlakke.

1.5.4.3.2.9 Die reguit lyn se vergelyking in verskillende vorms.

1.5.4.4 <u>Metodiek</u>

1.5.4.4.1 <u>Algemene metodiek.</u>

1.5.4.4.1.1 Doelstellings met die onderrig van wiskunde aan die middelbare skool.

1.5.4.4.1.2 Metodes by die bestudering van die wiskunde.

1.5.4.4.1.3 Struktuur in die wiskunde.

1.5.4.4.1.4 Literatuur. Bekendstelling met die literatuur en hantering van boeke en tydskrifte by die uitwerk van werkopdragte oor algemene onderwerpe uit die geskiedenis van die wiskunde of filosofie van wiskunde en ook oor onderwerpe wat betrekking het op die onderrig van die vak.

1.5.4.4.1.5 Evaluering in wiskunde.

1.5.4.4.1.6 Die volgende aangeleenthede i.v.m. die onderrig:

1.5.4.4.1.6.1 Skriftelike werk en die kontrole daarvan.

1.5.4.4.1.6.2 Huiswerk.

1.5.4.4.1.6.3 Handboeke.

1.5.4.4.1.6.4 Werkskema en verslag van gedane werk.

1.5.4.4.1.6.5 Lesvoorbereiding.

1.5.4.4.1.6.6 Hulpmiddels.

1.5.4.4.1.6.7 Differensiasie.

1.5.4.4.1.7 Wiskunde onderrig in ander lande. Bespreking van verskillende projekte soos bv. S.M.P., S.M.G. ens.

1.5.4.4.2 <u>Besondere metodiek</u>

1.5.4.4.2.1 Meetkunde.

1.5.4.4.2.1.1 Inleidende werk in meetkunde.

1.5.4.4.2.1.2 Euclidiese meetkunde as 'n deduktiewe stelsel.

1.5.4.4.2.1.3 Gebreke in die Euclidiese meetkunde.

1.5.4.4.2.1.4 Geselekteerde onderwerpe uit die leergang.

1.5.4.4.2.2 <u>Algebra</u>

1.5.4.4.2.2.1 Inleidende werk in algebra.

1.5.4.4.2.2.2 Geselekteerde onderwerpe uit die leergang.

1.5.4.4.2.3 Trigonometrie.

1.5.4.4.2.3.1 Inleidende werk in trigonometrie.

1.5.4.4.2.3.2 Geselekteerde onderwerpe uit die leergang.

1.5.4.4.2.4 Analitiese meetkunde.

1.5.4.4.2.4.1 Inleidende werk i.v.m. analitiese meetkunde.

1.5.4.4.2.4.2 Geselekteerde onderwerpe uit die leergang.

1.5.4.4.2.5 Rekenkunde.

1.5.4.4.2.5.1 Geselekteerde onderwerpe uit die leergang.

1.6 EKSAMENVRAESTELLE:

EERSTE STUDIEJAAR: 1 vraestel van 3 uur (Algebra)
1 vraestel van 3 uur (Goniometrie)

TWEEDE STUDIEJAAR: 1 vraestel van 3 uur (Algebra)
1 vraestel van 3 uur (Analitiese Meetkunde)

DERDE STUDIEJAAR: 1 vraestel van 3 uur (Lineêre Algebra)
1 vraestel van 3 uur (Analise)
1 vraestel van 3 uur (Analitiese Meet=
kunde en Komplekse getalle)

VIERDE STUDIEJAAR: 1 vraestel van 3 uur (Analise)
1 vraestel van 3 uur (Algebra en
Analitiese Meetkunde)
1 vraestel van 3 uur (Metodiek)."

APPENDIX B

"INHOUD COLLEGE DIDACTIEK VAN DE WISKUNDE

College 1. Uitdelen syllabus; eisen voor verklaring vakdidactiek;
Structuur van het college; werkgroepen; Structuur mammoetwet; bevoegdheidseisen; Rijksleerplan; CMLW; Ned. ver. v.Wiskundeleraren; Euclides.
Enkele problemen van de beginnende leraar; is "orde" een zelfstandig levend monster?; goed lesgeven is geen gave maar een talent dat ontwikkeld moet worden.

College 2. <u>Schema onderwijswerkplan;</u>

<u>Doelstellingen;</u> verschillende soorten doelstellingen; grove Bloom;
<u>Strategie;</u> eisen waaraan een strategie moet voldoen; lesgeven is meer dan gehoorzaam volgen van schoolboekjes.

College 3. Betekenis van de <u>variabele</u> (in de wiskunde); problemen die zullen gaan optreden als verschillende "soorten" variabelen worden geintroduceerd; dat die problemen zullen komen is logisch, want het is een foute strategie; aan welke eisen moet een strategie dan voldoen?; voorbeeld van een goede strategie bij het gebruik van letters (variabelen); formele achtergrond; het gebruik van kwantoren;

College 4. <u>Variabelen</u> (vervolg); een goede strategie; de introductie van variabelen en kwantoren in de brugklas tegen de achtergrond van de gegeven strategie; vergelijking van een aantal schoolboeken.
Moraal: aankweken van de moraal: doe vandaag niet wat je je leerlingen morgen moet afleren; aanleren van een goede strategie bij het gebruik van letters.

College 5. Functies en relaties; formele achtergrond; verschillende standpunten: het puristische en het gevoelsmatige standpunt; bespreken van de vraag of bij elk begrip een formele definitie behoort; de betekenis van domein en bereik in verband met definities van functies en relaties; uiteenzetten van verschillende strategieën; consequenties van elk.

College 6. Functies en relaties (vervolg); verschillende soorten diagrammen voor het uitbeelden van functies en relaties; voor- en nadelen van elk; keuze van het diagram afhankelijk van de strategie die gekozen is en deze weer van het doel; vergelijken van enkele schoolboeken.
Moraal: doe vandaag niet wat je morgen moet afleren; weet dat je kiezen kunt en doe dat dan ook op rationele gronden.

College 7. Invoering van nieuwe getallen

Negatieve getallen; formele achtergronden; ook hierbij zijn verschillende strategieën mogelijk: uitgaande van een aciomatiek van natuurlijke getallen de negatieve invoeren, of uitgaande van een aciomatiek van het lichaam der reële getallen de negatieve getallen ontdekken: consequenties van deze strategieën voor het schoolonderwijs; formele en intuïtieve; strategie; consequenties daarvan voor het leren optellen en vermenigvuldigen van gehele getallen; vergelijken van schoolboeken.
Moraal: Overzie de gevolgen van je daden.

College 8. Axiomatiek (in de onderbouw)

De commutatieve, associatieve en distributieve wetten in de brugklas; waarom deze wetten in de brugklas?; vergelijking met de deductieve en de intuïtieve opbouw van de meetkunde; bezwaar tegen een deductieve opbouw; idem tegen een intuïtieve opbouw; kan het wiskundeonderwijs concentrisch gegeven worden?
Moraal: zoeken naar een paar specifieke doelen van het wiskundeonderwijs.

College 9. Goniometrie

Vijf verschillende strategieën voor het onderwijs in sin., cos. en tg. Op grond waarvan kies je nu de beste strategie; het woord beste is hier niet goed, beter is : optimale; pleidooi voor de strategie van cirkelfuncties via opwindfunctie.
Moraal: wat de boer niet kent dat vreet ie niet, is een slechte houding voor een leraar.

College 10. <u>Logaritme en wortels;</u>

formele achtergrond; het verouderen van de klassie= ke strategie; een paar modernere strategieën. Moraal: Alles hangt met alles samen. Ja, maar laat dat dan ook merken.

College 11. <u>Analyse</u>

<u>Continuiteit en limieten;</u> welke eerst? de fouten van de traditionele strategie; het gebruik van de optimale terminologie; de keuze van de best passen= de diagrammen; pleidooi voor de definitie van limieten met behulp van continuiteit en dit met meetkundige topologische terminologie; voordelen in de toekomst van deze strategie.
Moraal: de keuze van de optimale strategie hangt niet alleen af van het einddoel, maar ook van onderwijskundige motieven: o.a. onderwijs je leerlingen niet meer dan één ding tegelijk.

College 12. <u>Analyse</u> (vervolg)

Afgeleide, primitieve functie, diff. vergelijkingen; gevolgen van de bij continuiteit gekozen strategie; het gebruik van differentialen; de integraal als aangroeiing van primitieve; logisch gevolg van de eerder gekozen strategie; overbodigheid van de Riemannintegraal;
<u>Meetkunde.</u> De meetkunde van de onderbouw in het nieuwe leerplan.

College 13. <u>Analyse</u> (vervolg)

Waarom differentiaalvergelijkingen?; hoeveel, welke, en hoe stevig?; noodzaak van het invoeren van e-machten.
Moraal: bedenk ook eens wat je leerlingen na school praktisch van de wiskunde nodig hebben.

<u>Meetkunde</u> (vervolg)

Einde eerste semester, tevens einde van het onder= werp strategieën. In het tweede semester gaan veel studenten hospiteren, daarom nu veel klassesituaties.

College 14. Een onderwijstheorie (waarnemen → sorteren → abstra= heren → generaliseren → controleren aan de hand van voorbeelden uit de klassepraktijk; analyse van enkele korte wiskundefilmpjes, welke fasen uit de theorie komen er niet in voor?
Moraal: vele leraren passen onbewust deze fasen-theorie toe, het zijn o.a daarom goede leraren; professionaliteit van het leraarsberoep bestaat uit het bewust toepassen van onderwijstheorieën.

College 15. Vertoning van een stuk les op de video; analyse op grond van de fase-theorie; slechte resultaten zijn gewoonlijk het gevolg van een te korte sorteer- en abstractiefase.
Moraal: een slechte onderwijsprocedure geeft on= herroepelijk wanorde.

College 16. Beluisteren van een band van een stuk les; niemand begrijpt er wat van; is gevolg van een slechte procedure; hoe zou het beter kunnen?; voorbereiding van dezelfde les op grond van de fase-theorie; de leraar had teveel vertrouwen in het (slechte) schoolboek.
Moraal: een slechte procedure geeft slechte resul= taten; de boekjes zijn ook niet allemaal zo ideaal.

College 17. Bespreken van een stuk tekst uit een boek; analyse op grond van fase-theorie; het gevoel van teleur= stelling bij het lezen van de tekst is te verklaren uit het ontbreken van een of meer fasen.
Moraal: als een of meer fasen in het boekje ont= breken moet de leraar aanvullen.
Hoewel de procedure nog wel op een achtergrond blijft hangen wordt in de volgende colleges meer nadruk gelegd op werkvorm en interactie.

College 18. Vertoning van een stukje les op de video; betekenis van het stellen van vragen door de leerlingen; wat voor soort vragen stellen leerlingen; hoe krijgt de leraar informatie over het slagen c.q. mislukken van het leerproces.
Moraal: een intelligente vraag van een leerling geeft informatie aan die leerling, een domme vraag geeft informatie aan de leraar; domme vragen van leerlingen zijn onbedoelde terechtwijzingen aan de leraar.

College 19. Vertoning van een stuk les op de video; hoe begin je de les; betekenis van een duidelijke regulatie; onduidelijke afspraken hebben wanorde tot gevolg; methoden om huiswerk van leerlingen te controleren; als leerlingen hun eigen werk kunnen controleren is dat beter dan wanneer de leraar het moet doen, hoe krijg je leerlingen zover?; motivatie van leerlingen door belonen en straffen.
Moraal: wees duidelijk, wees eerlijk, wees conse= quent.

College 20. Vertoning van een stuk les op de video; invloed van de hulpmiddelen bord, boek, stem; ordelijk werk bevordert ordelijk werk; als hulpmiddelen het slechte voorbeeld geven moet je als leraar niet teveel verwachten; hoe een leerling zich aan een opdracht kan onttrekken zonder dat de leraar het merkt.
Moraal: geeft het goede voorbeeld.

College 21. De kunst van het vragen stellen; hoe geduldig kan een leraar zijn?; hoe geduldig kunnen leerlingen zijn; verschillende soorten vragen; wat doe je als een leerling een vraag of een opdracht niet kan beantwoorden?; wie krijgt er eigenlijk infor= matie bij het vragen, de leraar of leerling?; (hoe) weet de leerling dat hij informatie krijgt als hem een vraag gesteld wordt?; hoe kan een leerling dat soort informatie gebruiken bij zijn keuze van het schooltype?
Moraal: hoe leer je leerlingen zichzelf de juiste vraag te stellen?

College 22. Hoe behandel je als leerling(en) een opdracht niet konden volbrengen; hoeveel tijd besteedde je aan het oplossen van so 'n opdracht; voorbeelden van opdrachten die snel en die langzaam afgedaan moeten worden.Moraal: blijf niet doorzeuren over onbelangrijke zaken; denk steeds aan de fasentheorie.

College 23. Problem-solving als onderwijsdoel; hoe leer je leerlingen zichzelf de juiste vragen te stellen; leerlingen moeten de fasentheorie ook kennen; vraagstukken maken is geen doel; vraagstukken oplossen wel.
Moraal: als je iemand iets wilt leren moet je zorgen dat hij weet hoe hij het kan leren; verwacht geen resultaten van iets wat niet geexpliciteerd is.

College 24. Het gebruik van het bord en de overhead-projector; voorbereiding van een goede indeling; wat moet je niet van te voren op een transparant zetten?; wat is belangrijker op het bord: de oplossing van het probleem of de overwegingen die tot die oplossing leiden?
Moraal: geeft niet te weinig informatie, maar vooral ook niet te veel.

College 25. Foutenanalyse; veel voorkomende fouten; poging tot rubricering ervan; hoe herkent de leraar de rubriek?; hoe kan hij de waarschijnlijkheid van het optreden ervan verkleinen? Is een domme fout eigenlijk wel zo dom?
Moraal: voorkomen is beter dan genezen.

College 26. Toetsen; wat is een toets?; waarvoor dient hij?; wat doe je ermee?; toets je werkelijk wat je denkt dat je toetst; beoordeling; vijven en zessen.
Moraal: lees goed, er staat niet wat er staat.

College 27. Differentiatie binnen het onderwijs.

College 28. Methoden en werkvormen.

<u>INHOUD WERKGROEPEN DIDACTIEK VAN DE WISKUNDE</u>

(na college 2)

1. <u>Het Utrechts proefwerk;</u> Maken van een toets die door ± 300 brugklasleerlingen is gemaakt. Bespreken van de toets met als achtergrond Bloom I. (Brugklas = oorgangs= klas van primêre na sekondêre skool, St. 6 dus.)
Doel: kennis laten maken met Bloom's taxonomy en met problemen van het operationaliseren van doelstellingen.
Moraal: alles is niet zo vanzelfsprekend als het lijkt.

(na college 4)

2. <u>Ongelijkheden.</u> Bestudering van een paar schoolboeken; nagaan of een strategie voor het gebruik van variabelen te herkennen is; zo ja, schematisch weergeven van zo 'n strategie.

(na college 6)

3. <u>Lineaire programmering.</u> Bestudering van een toepassings=mogelijkheid van functies en relaties; nagaan hoe die mogelijkheid aanwezig is bij een andere strategie.

(na college 8)

4. <u>"Wortels".</u> Bespreken en verbeteren van een thuis bestu=deerde strategie voor "wortels" (katern van G.I. Bunt). Samen opstellen van alternatieve strategieën, met bespre=king van de konsekwenties (en uiteraard het doel).
Doel: het leren kennen van de nieuwe aanpak van dit onder=werp, uitdiepen begrip strategie, en zijdelings eerste kennismaking met G.I..

(na college 10)

5. <u>Meetkunde in de onderbouw.</u> Bespreken en verbeteren van en thuis bestudeerd hoofdstuk uit een schoolboek. Vooral ook het aantal opdrachten.
Doel: kennismaken met nieuw stuk meetkunde en het zelf met concreet materiaal laten werken van de leerlingen.
Bespreken en vergelijken van thuis bestudeerde brugklas=leerboeken (transformaties in de meetkunde). Naar voren laten komen van het doel, de gevolgde strategie, en de overeenkomsten en verschillen in de diverse boeken.

(na college 12)

6. <u>Vectoren.</u> Onderzoek van de verschillende betekenissen die dit woord kan hebben; hoe moeten we er mee werken op school.

6a. (voor belangstellenden). Verslag van een stage nieuwe stijl; drie studenten hebben in teamverband drie maanden onder leiding van een mentor gewerkt.

EINDE EERSTE SEMESTER

(na college 14)

7. Studenten in kleine groepjes een opgave laten maken uit Westermann I (meetkunde met vectoren). Bij ieder groepje een observator. Na oplossing rapportage, met confrontatie van eigen aanpak van het probleem met de fasen.
Doel: fasen-theorie nader bekijken om daardoor voor- en nadelen te leren kennen.

(na college 16)

8. Les op de video-recorder bekijken. Studenten gericht laten leren observeren door gerichte vragen te stellen t.a.v. de fasen en de interaktie.
Doel: observatiegevoeligheid vergroten.

(na college 18)

9. Lesplan maken van een les over een thuis bestudeerde paragraaf uit de Schotse methode (samenstelling van 2 spiegelingen in snijdende rechten).
Drie typen lessen laten maken a) leerlingen werken zelf uit het boek (inleiden? tussentijds gezamentlijke bespreking? etc.); b) leraar geeft les uit het hoek (wat vertellen resp. vragen? wat zelf laten doen; c) leraar besluit tot ander strategie (welke? waarom? hoe?).
Doel: naar voren laten komen van voorwaarden en problemen bij diverse werkvormen.

(na college 20).

10. Lesplan maken over een onderwerp uit Analyse I van J van Dormolen (raaklijn aan een kromme).
Bespreken van gegeven les, opnieuw laten geven door andere student, etc.
Doel: door les te geven ontdekken waar de problemen liggen en nagaan hoe dit bij de lesvoorbereiding reeds kan.

(na college 22)

11. Maken van een wiskunde-praktikum "Groepen van de orde 4" in groepjes.
Bespreken van eigen ervaringen en mogelijkheden van toe=passing in de klas.
Doel: hulpverlening bij pogingen om groepswerk toe te passen in de klas.
Het laten zien van de voorwaarden, de beperkingen etc.

(na college 24)

12. Maken van tranparanten en andere hulpmiddelen.
Moraal: technische hulpmiddelen ondersteunen, maar mogen geen eigen leven gaan leiden.

(na college 26)

13. Laten opstellen van een repetitie over een nog vast te stellen onderwerp.
Moraal: vraag niet meer dan je je leerlingen hebt geleerd; wel minder?

14. (Na onderlinge afspraak)"

FORM A CAPE EDUCATION DEPARTMENT No. 100

STUDENT: .... KOLLEGEKLAS: .... SKOOL: .... ONDERWERP: .... ST.: ......

KRITERIA		Uitste= kend	Baie goed	Goed	Gemid= deld	Onder gemid.	Swak	Uiters swak	Eindpunt
1. Voorkoms en persoonlike eienskappe	Houding, netheid, selfvertroue, geesdrif, toeskietlikheid, aan= wensels.	7	6	5	4	3	2	1	..... uit 7
2. Voorberei= ding van les (Uitge= skrewe les)	Doelstelling, metodiek, netheid van aantekeninge, toereikendheid, geskiktheid, logiese ontwikkeling, relevansie, interessantheid, oorspronklikheid, hulpmiddele (hoeveelheid en geskiktheid) aandeel van en uitdaging aan leerlinge.	19–21	16–18	13–15	10–12	7–9	4–6	1–3	..... uit 21
3. Aanbieding van les	Inleiding en motivering, aanbieding, beheersing van leerstof, aan= pasbaarheid, voortsetting of toepassing, korrelasie, resultate be= haal, pogings tot individuele hulp.	31–35	26–30	21–25	16–20	11–15	6–10	1–5	..... uit 35
4. Verhouding tot leer= linge	Atmosfeer wat geesdriftige en genotvolle samewerking bevorder, vriendelikheid sonder gemeensaamheid, wedersydse respek, dissipline	7	6	5	4	3	2	1	..... uit 7
5. Reaksie van leerlinge	Belangstelling, geesdrif, samewerking, aktiewe deelname, aanvaar= ding van uitdagings.	13–14	11–12	9–10	7–8	5–6	3–4	1–2	..... uit 14
6. Klastegniek	Rangskikking en distribusie van benodigdhede en hulpmiddele, doel= treffende aanwending van hulpmiddele (skryfbord, meganiese en ou= diovisuele hulpmiddele, ens.) stemgebruik (artikulasie, uitspraak, wisseling t.o.v. tempo, toonhoogte en volume), stel van vrae.	13–14	11–12	9–10	7–8	5–6	3–4	1–2	..... uit 14
7. Taalbeheer	Korrekte taalgebruik.	7	6	5	4	3	2	1	..... uit 7

Opmerking: ....

....

....

....

TOTAAL .... uit 105

Persentasie ....

Datum: ....

.... Dosent

FORM B

ONDERWYSERSKOLLEGE, BLOEMFONTEIN P.O. 3

VIR KLASONDERWYSERS(ESSE): EVALUERINGSKAAL VIR PROEFONDERWYSLESSE VAN DERDEJAARS

STUDENT: ____________________ (korrekte voorletters en van) KLAS EN AFDELING: (SPES.VAK) ______

SKOOL: ____________________ TYDPERK VAN SKOOLBESOEK ____________

AANTAL DAE AFWESIG __________ REDE VAN AFWESIGHEID ____________

IS U HIERIN GEKEN? ____________

VERSLAG OOR DIE STUDENT: (N.B. Onderstreep of voeg by waar van toepassing)

1. VOORBEREIDING: Joernaalwerk: Netjies/gemiddeld/slordig.
2. LEERSTOF: Baie goed gekies/goed/Voldoende/onvoldoende/swak
3. LEERMETODE: Doeltreffend/redelik suksesvol/ondoeltreffend
4. LEERMIDDELS: (a) Geskiktheid: Baie goed/goed/gemiddeld/swak
   (b) Aanwending: Baie suksesvol/goed/gemiddeld/swak
5. KLASBEHEER: (a) Kontak : Goed/gemiddeld/swak
   (b) Kontrole : Goed/middelmatig/swak
   (c) Atmosfeer: Aangenaam/redelik/onaangenaam
6. OPTREDE VOOR KLAS: Besielend/wakker/kalm/met selfvertroue/onseker/onbeholpe/kleurloos
7. GEBRUIK VAN VRAE: Uitstekend/baie goed/goed/gemiddeld/swak
8. TAALGEBRUIK: (a) Afrikaans: Keurig/duidelik/gangbaar/onduidelik/onversorg
   (b) Engels : Keurig/besonder goed/goed/redelik/baie swak
9. SKRYFBORDWERK: (a) Gebruik : Doeltreffend/redelik/swak
   (b) Skrif : Netjies/leesbaar/slordig
10. TOEPASSING VAN LES: Oorspronklik/doeltreffend/redelik/swak
11. SOSIALE OMGANG TEENOOR PERSONEEL EN LEERLINGE: Gesellig/vriendelik/gesonde verhouding/familiêr/afsydig/teruggetrokke
12. GESINDHEID: Hoflik/gewild/bedagsaam/ongemanierd
13. STIPTHEID: Altyd stip/af en toe laat/dikwels laat
14. ALGEMENE OPMERKINGS: ____________________

15. GLOBALE PUNT __________ (75+ = uitstekend, 65+ = baie goed, 55+ = goed, 50+ = bevredigend, 49- = swak (drüip)

HANDTEKENING VAN ONDERWYSER(ES): ____________________

HANDTEKENING VAN PRINSIPAAL: ____________________

Verseël in koevert en gee aan studenteleier.

FORM B_2

ONDERWYSERSKOLLEGE, BLOEMFONTEIN. P.O. 3(a)

ONDERWYSER(ES) SE RAPPORT OOR PROEFONDERWYS VAN DERDEJAARS.

STUDENT: ______________________ SPES. VAK ______________________

SKOOL: ______________________ TYDPERK VAN SKOOLBESOEK: ________

VERSLAG OOR DIE STUDENT: By die beoordeling van die lesse moet gelet word op: Voorbereiding, keuse van leerstof, inleiding, aanbieding en gebruik van vrae, taalgebruik, skryfbordwerk, ens.

LEIDRAAD VIR PUNTETOEKENNING: (75+ = uitstekend, 65+ = baie goed, 55+ = goed, 50+ = bevredigend, 49- = swak)

	DATUM	VAK	ONDERWERP	PUNT	OPMERKING
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					
			GEMIDDELDE PUNT:		

ALGEMENE OPMERKING VAN VOOGONDERWYSER/ES: ______________________

____

____

OPMERKINGS VAN DIE PRINSIPAAL: ______________________

____

____

______________________ KLASONDERWYSER(ES)

______________________ PRINSIPAAL.

FORM C

P.O. 10

ONDERWYSKOLLEGE POTCHEFSTROOM

EVALUERINGSVORM: DOSENT:

STUDENT: .... KURSUS EN JAAR: ......E/e: ...

SKOOL: .... ST: .... LESMEDIUM: ....

DATUM: .... VAK: .... LESTIPE: ....

ONDERWERP: ....

	HL		OSK		G	SL		Dr.			
	10	9	8	7	6	5	4	3	2	1	KOMMENTAAR
VOORBEREIDING EN VOORBEREIDHEID											....
KLASKAMER= PERSOONLIKHEID											....
ONDERRIGMETODE -PROSEDURE -TEGNIEKE											....
TAALGEBRUIK VOORDRAG EN HULPMIDDELS											....
RESULTAAT											....

....

FORM D

Verwysing ....

PRETORIASE ONDERWYSKOLLEGE

EVALUERINGSKAAL VIR PRAKTIESE ONDERWYSLESSE

SKOOL: ______________________

1. STUDENT: ______________________ 5. GROEP: ______________________
2. VAK: ______________________ 6. DATUM: ______________________
3. STANDERD: ______________________ 7. TYDSDUUR: ______________________
4. TEMA: ______________________ 8. LESONDERWERP: ______________________

A VOORBEREIDINGSBOEK — SIMBOLE — OPMERKING - SAAKLIK

1. Onderwysdoelstellings — ABCD E ______________________
2. Die lesvorm
   2.1 Grondvorme — ABCD E ______________________
   2.2 Metodes — ABCD E ______________________
3. Didaktiese Modaliteite
   3.1 Hulpmiddels/Materiaal — ABCD E ______________________
4. Gehalte van Joernaalwerk — ABCD E ______________________

B DIE LESVERLOOP

1. Aktualisering van voorkennis — ABCD E ______________________
2. Probleemstelling — ABCD E ______________________
3. Eksposisie van die leerinhoud — ABCD E ______________________
   3.1 Beheersing van leerinhoude — ABCD E ______________________
   3.2 Gebruik van vrae — ABCD E ______________________
   3.3 Korrekte taalgebruik — ABCD E ______________________
   3.4 Skryfbordwerk — ABCD E ______________________
   3.5 Aktiewe betrokkenheid van leerling — ABCD E ______________________
   3.6 Aanwending van hulpmiddels/ of materiaal — ABCD E ______________________
4. Klasbeheer — ABCD E ______________________
5. Aktualisering van die leerinhoud — ABCD E ______________________
6. Funksionalisering — ABCD E ______________________
7. Bereiking van doelstellings — ABCD E ______________________

C PERSOONLIKHEID

1. Uiterlike voorkoms — ABCD E ______________________
2. Persoonlikheidsindruk — ABCD E ______________________
3. Gesindheid — ABCD E ______________________

D EVALUERING

Beskou u die student as geskik vir die onderwys? Ja/Nee/Twyfelagtig

Handtekening: ______________________ Departement: ______________________

% ______________________ Les % ______________________ Medium

Sleutel: A Bokant 80 % B 70 - 79 % C 60 - 69 %
D 50 - 59 % E 49 % en minder (druip)

FORM E

UNIVERSITY OF CAPE TOWN : FACULTY OF EDUCATION

N.B. : Circle the rating for each item

Name	Teaching Assessment
	1+ 1 1- 2+ 2 2- 3+ 3 3- F+ F

Course	Language Medium	Language Assessment
		H1 H2 H3 L+ L L- F

School	Std.	Title of Lesson

Lesson Planning and Implementation	7	6	5	4	3	2	1
Content : Adequacy and Mastery	7	6	5	4	3	2	1
Clarity of Exposition	7	6	5	4	3	2	1
Questioning	7	6	5	4	3	2	1
Pupil Participation	7	6	5	4	3	2	1
Achievement of Lesson Objectives	7	6	5	4	3	2	1
Rapport with Class and Reinforcement of Pupil Response	7	6	5	4	3	2	1
Class Management	7	6	5	4	3	2	1
Oral Communication	7	6	5	4	3	2	1
Use of Blackboard and Teaching Aids	7	6	5	4	3	2	1

General Comments: ....

....

....

Date	Supervisor

FORM F_1

UNIVERSITY OF NATAL

FACULTY OF EDUCATION

REPORT ON LESSON

Student's Name ....

School .... Standard or Form ....

Date of lesson .... Subject ....

It is suggested that the following points might be borne in mind in compiling this report: (a) voice, language and general bearing; (b) adequacy of lesson preparation; (c) use of illustrative material and apparatus, including blackboard. Variety in lesson presentation; (d) efficacy of teaching methods; (e) general class management, and flexibility in control; (f) general success of lesson and extent of class participation.

REPORT

Signed ....

Senior Teacher
University Supervisor
School Principal

FORM F_2

UNIVERSITY OF NATAL — CONFIDENTIAL

FACULTY OF EDUCATION: REPORT ON TEACHING PRACTICE

Student's Name: Mr./Mrs/Miss ....

Teaching Subjects: (a) ....
(b) ....
(c) ....

Forms and subjects taught: ....

General report: Please appraise the student by placing an x at the appropriate point on each line. Comments would be of additional value.

Key: A, outstanding; B, strong; C, average; D, on the weak side; E, unsatisfactory.

FACTORS — A B C D E

1. Personal qualities as a teacher.

   e.g. discretion, friendliness, initiative, reliability, rapport with children, fairness, relationships with staff, appearance. Comments: ....

2. Teaching ability. — A B C D E

   e.g. preparation, planning and presentation of lessons; class control, intelligent variation of methods, indivi= dual assistance to pupils, adequacy of background knowledge. ....

   Comments:

   A B C D E

3. Overall standard reached as a student teacher.

   Comments: ....

GENERAL REMARKS:

....	....	....
Signature of Principal/Head of Department	Date	Boys' / Girls' High School

FORM G_1

FAKULTEIT VAN OPVOEDKUNDE, U.O.V.S.

Konfidensiële Verslag i.v.m. lesse van studente gedurende Skoolbesoek

1. **ALGEMEEN:** Skool .... **Tydperk:** ....

   Student: ....

   Klasse en aantal lesse in elke vak: ....

   ....

2. Verslag: Onderwysers word asseblief vriendelik versoek om baie kortliks verslag te doen i.v.m. die volgende:

   (i) Voorbereiding, lesbeplanning en bekendheid met leerstof:

   (ii) Inleiding van lesse:

   (iii) Vraagtegnieke van student en belewing van lesse:

   (iv) Verduideliking, Beklemtoning, Drilwerk en Dryfkrag:

(v) Spreekstem en Tempo:

(vi) Persoonlikheid, Algemene Optrede en Klasbeheer:

(vii) Planmatige ontwikkeling en afronding van lesse:

(viii) Spesiale Oorwegings i.v.m. Vakmetodieke:

(ix) Algemene Indruk:

3. SYFERTOEKENNING VIR LESSE: Om te slaag word 'n minimum van 50% vereis, terwyl 75% 'n onderskeidingsyfer is.

VAK	SYFER	HANDTEKENING
(a)		
(b)		
(c)		

....
HANDTEKENING VAN HOOF

Hoofde van skole word asseblief vriendelik versoek om hierdie verslag onmiddellik na afloop van die skoolbesoek te stuur aan:

Die Dekaan,
Fakulteit van Opvoedkunde,
U.O.V.S.,
Posbus 339,
BLOEMFONTEIN.

FORM G_2

UNIVERSITEIT VAN DIE ORANJE-VRYSTAAT

HANDLEIDING VIR ONDERWYSERS EN STUDENTE T.O.V. DIE BEOORDELING VAN PROEFLESSE

(a) Die Student-onderwyser:

(i) Optrede: simpatiek, aangenaam, senuagtig, vol selfvertroue, bemoedigend, vriendelik, ferm, ywerig, lewendig, sin vir humor, kontak met klas?

(ii) Posisie voor klas: Goed, nie sigbaar vir almal nie, te na of te ver van klas, te veel met rug na klas, hande agter die rug, arms gekruis, leun op stoel of tafel, hand in die broeksak, te veel rondloop, te lank op een plek stilstaan, hinderlike gewoontetjies?

(iii) Voorkoms: netheid, kleredrag - nie uitspattig of slordig nie.

(iv) Stem: duidelik, sonder stremming, toonhoogte, praat in keel, goeie stembeheer, vlot, welluidend?

(v) Geesteshouding teenoor werk en leerlinge: belangstelling, geduld, konsensieus, onpartydig, oorspronklik, taktvol, simpatiek, vriendelik, beleefd en entoesiasties.

(vi) Voorbereiding: Is student deeglik voorberei, beheers hy die leerstof?

(vii) Voorbeeld: Is die karakter en persoonlikheid soos spreek uit die optrede in alle opsigte 'n navolgingswaardige voorbeeld?

(b) Die les self:

(i) Inleiding: motief vir nuwe werk, probleemstelling, is goed van vorige kennis gebruik gemaak; vrae: geskik en saaklik?

(ii) Doel: Het onderwyser die doel duidelik raakgesien, het die kinders die doel gesnap, onmiddellike en uiteindelike doel, is belangstelling opgewek?

(iii) Leerstof: pas dit by die klas, te maklik of te moeilik, genoeg, te veel of te min, was die onderwyser seker van sy feite, is die leerstof onder die nodige hoofde gerangskik, vorm die leerstof 'n afgeronde geheel, totaalverband, kontinuïteit tussen bekende en onbekende?

(iv) Metode: beste, geskik, ter sake, was dit duidelik en met insig in die notas gestel, was daar variasie in metodes, was dit tradisioneel of getuig dit van oorspronklikheid, word by beskrywings en verduidelikings na die kinders se peil afgedaal, word opvoedkundige beginsels in ag geneem?

(v) Leermiddels: keuse, genoeg of te veel of te min, hoe is dit gebruik; spontaan tydens les, kunsmatig voor of na aanbieding, vergeet?

(vi) Leerlingaktiwiteite: was hul spoedig bewys dat hul met iets betekenisvol besig gehou word, was leerlinge aktief besig, is hulle deur die geskiktheid van onderwysmetodes tot voortdurende werksaamheid beweeg, wend hul pogings aan tot selfontdekking, is hulle geboei, toon hulle belangstelling, het hulle respek vir die onderwyser, is daar samewerking en was daar vordering?

(vii) Samevatting: is die kern van die les ingesien tuisgebring en beklink, is die doel bereik?

(viii)......../2

(viii) Swartbordwerk: met 'n skoon bord begin, was dit spontaan tydens les gegee, het swartbordwerk sistematies gegroei soos les vorder, van links na regs, logies en kronologies, goeie opsommings, illustrasies, is skrif duidelik, was dit 'n waar=devolle hulpmiddel?

(ix) Hersiening: in die regte volgorde, het vrae op kernfeite betrekking, toon leer=linge se antwoorde dat hulle insig in die werk het, hoe word opgetree teenoor verkeerde idees by kinders, was die tipe hersiening paslik?

(x) Toepassing: is goeie voorbeelde gekies om die leerlinge oefening te gee in die toepassing van hulle kennis, was toepassingsvrae of -oefeninge of -probleme gegra=deer volgens moeilikheidsgraad, het die kinders onafhanklik van mekaar ook gewerk, is goeie leiding gegee by groepaktiwiteite, was die resultate goed?

(xi) Ontwikkeling: Was daar gedurig ontwikkeling en kontinuïteit in die les, het die een stap spontaan oorgegaan in die ander sodat die geheel-in-druk van die les 'n afgeronde geheel vorm?

(xii) Taalgebruik: Uitspraak korrek en duidelik, grammatikale foute, hinderlike en soms plat uitdrukkings, is gelet op kinders se taal, word voertaal goed beheer en word in alle opsigte beskaafde taal gepraat?

(xiii) Dissipline: Hoe was klasbeheer, goeie houvas op kinders, ordelikheid, beheersd=heid, bly kinders gedurig besig, praat kinders gelyk, te veel lawaai, 'n te losse gees of te strenge dissipline, kontak met hele klas en individuele leer=linge? Hoe word gewerk met afkeuring of goedkeuring, beloning, prys van leer=linge en straf?

(xiv) Tydsindeling: Was stappe eweredig versprei, voor of na die tyd klaar, te veel afgedwaal van die punt, te lank by een aspek of stap vertoef en sodoende die geheelbeeld laat verlore gaan?

(xv) Waardering: Was die onderwys meer as feite en kundighede? Het die kinders die leerstof beleef en werklik geniet of het dit hulle verveel? Was die op=voeding van die kind belangriker as die leerstof?

(xvi) Werkskema: Het die les in die skema gepas of was dit geïsoleerd? Is daar totaalverband met vorige lesse en lesse wat in die toekoms sal volg?

DEPARTEMENT ALGEMENE DIDAKTIEK.

U.O.V.S.
BLOEMFONTEIN

FORM G3

U.O.V.S.: KRITIESE EVALUERING VAN (PROEF)LES

Student: .... Skool: ....

Onderwerp: .... Vorm/St. .... Datum: ....

	Voortreflik	*Goed*	*Redelik*	*Probleme*
1. Voorbereiding en Lesbeplanning Skema in orde? Vertroudheid met stof. Doelgerigtheid ens.				
2. Lesontleding, Onderwysmetodes en -Tegnieke, Leermiddele. Onderwysvermoë (a) **Inleiding:** Aansluitingsvrae; doelstelling en motivering; gereedheid vir nuwe leerstof ens.				
(b) **Ontwikkeling:** (i) **Karakter van Les:** Les of lesing? Leerlinge se les (of is hul dood gepraat)? Met oorgawe gewerk? Tempo?				
(ii) **Sisteem:** Logies, samehangend en deeglik gekontroleer tussen verskillende ontwikkelingstrappe?				
(iii) **Algemene Onderwysmetodes:** Geskikte keuse? Afwisseling? Sosialisering, bekende na onbekende, geheel na dele ens.				
(iv) **Vraagtegnieke, belewing, aktivering:** Hele klas betrek? Vrae gedifferensieer? Denkvrae, ontwikkelingsvrae ens.?				
(v) **Skoolbord e.a. hulpmiddele:** Planmatig of deurmekaar? Netheid en duidelikheid. Oorspronklikheid ens.				
(vi) **Korrekte gebruik van handboek?**				
(c) **Afronding en Toepassing:** Samevatting. Werkopdragte. Is leerlinge tot selfstudie gemotiveer?				
(d) **Onderwysvermoë:** Duidelikheid van stelling, **beklemtoning,** trefkrag, ens.				
3. Besondere vakmetodiek (Grondliggende oorwegings)				
4. Algemene Optrede, Klasbeheer, Persoonlikheid ens. (a) **Persoonlikheidsindruk:** Voorkoms. Gesindheid. Gemaklik, kalm en met selfvertroue? Humorsin?				
(b) **Optrede:** Dinamies of eentonig? Opgewek of dooierig? Simpatiek dog beslis en ferm? Besielend en **oortuigend**?				
(c) **Lesdissipline:** Ordelike gang of deurmekaarpratery? In beheer van les gebly? Hantering van onverwagte.				
(d) **Spreekstem en Taalgebruik:** Duidelik? Tempo, toonhoogte en afwisseling korrek? Taal suiwer of slordig?				
5. Klasreaksie: Belangstelling gewek? Oplettend of belangeloos? Samewerking? Meelewing en leerlingaktiwiteit?				

Dosent: ....

FORM H1

UNIVERSITEIT VAN PRETORIA

SKOOLPRAKTYK: FAKULTEIT OPVOEDKUNDE

Lespunt

Medium

Naam van Student: mnr./mej./mev. ....

Kursus: .... Datum: ....

Skool: .... Standerd: ....

Vak: .... Kritieklesno.: ....

....

Handtekening

UNIVERSITEIT VAN PRETORIA

SKOOLPRAKTYK: FAKULTEIT OPVOEDKUNDE

Verwysing

Naam van Student: mnr./mej./mev. ....

Kursus: .... Datum: ....

Skool: .... Vak: ....

Algemene opmerking

....

Lespunt

Medium

....

Handtekening

FORM H_2

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

FORM A. (To be completed by the class teacher)

NAME OF STUDENT:

SCHOOL:

SYMBOLS FOR EVALUATING LESSONS DURING TEACHING PRACTICE

75 % + ...	A	Excellent
65 % - 74 %	B + ...	Good
55 % - 64 %	B	Satisfactory
50 % - 54 %	B -	Adequate though weak
Less than 50 %	C	Inadequate

N.B. A symbol must be allocated for each subdivision as well as for impression of the whole (Item 10).

1. PLANNING:
Were the student's lesson schemes clear and systematic? (Attention should be paid to the general approach to and design of lessons rather than to a full rendering of the contents).

2. ARRANGEMENT OF SUBJECT MATTER:
Did the student's planning in each case give rise to an orderly system which was recognizable in the actual lessons given?

3. DESIGN AND USE OF TEACHING AIDS:
Did the student show evidence of insight as regards the selection and use of visual and other aids in the teaching situation?

4. INTEREST AND ACTIVITY OF PUPILS:
Was each lesson planned round a problem and did it link up with the experience of the pupils? Did the student select methods which were most suited to the nature of the subject matter and to the general level of ability of the pupils?

5. MANAGEMENT AND CONTROL OF CLASSES:
Did the student succeed during the course of lessons in involving the whole class in the learning situation and in that way ensure sound individual control?

6. TEMPO AND USE OF AVAILABLE TIME:
Did the lessons form well rounded entities and did they proceed at an even and moderate tempo? Was the student able to cope with sudden and unexpected situations which could interfere with this aspect of a lesson?

7. ROUNDING OFF AND APPLICATION:
Was the application always an indispensable part of each lesson or was it merely added in a formal way to satisfy theoretical requirements for a good lesson?

8. APPEARANCE AND GENERAL CONDUCT:
The following factors could be considered under this heading: use of language, clarity of speech, general neatness, selfconfidence, position before the class, etc.

9. GENERAL IMPRESSION:

....

....

10. OVERALL EVALUATION: .... SYMBOL: ....

DATE: ....

(Teacher's Signature)

JV/MR
BJE.
8.11.72

1.8/16/73.

FORM H_3

UNIVERSITY OF PRETORIA

FACULTY OF EDUCATION

FORM B. CONFIDENTIAL REPORT CONCERNING STUDENT TEACHER. (TO BE COMPLETED BY THE HEADMASTER/MISTRESS, IN CONSULTATION WITH THE CLASS TEACHER CONCERNED.

NAME OF STUDENT: COURSE:

PERIOD OF TEACHING PRACTICE: From .... To ....

Will you please indicate, on the basis of the following questions, your opinion of the student's possibilities and/or shortcomings as a future teacher by placing a cross in the appropriate column.

	EXCELLENT	GOOD	FAIR	POOR
1. Did you have the necessary co-operation of the student?				
2. Did he/she perform tasks allotted to him/her to your complete satisfaction? (a) In school				
(b) In connection with extramural activities?				
3. Was the student's conduct towards the staff courteous yet easy?				
4. What do you think of the student's re=lationship with the pupils outside the classroom situation?				
5. Does his/her appearance make an impression of neatness?				
6. Taking all the student's potentialities in=to consideration, what do you think of him/her as a future teacher?				

Have you any complaints regarding this student? Please specify fully:

....

....

....

....

GENERAL REMARKS

....

....

....

....

DATE: ....

SCHOOL: ....

....
(Signature of headmaster/mistress or his/her authorized deputy).

JV/SF.
BJE.
8.11.1972 1.8/17/73.

FORM J

Fakulteit Opvoedkunde

POTCHEFSTROOMSE UNIVERSITEIT VIR CHRISTELIKE HOËR ONDERWYS

Student ....

Datum .... Klas ....

Onderwerp ....

Lespunt

%

		1	2	3	4	5
1.	Voorbereiding					
2.	Doel					
3.	Hersiening					
4.	Motivering					
5.	Optrede					
6.	Klasbeheer					
7.	Leermetode					
8.	Leermiddele					
9.	Skryfbordwerk					
10.	Vrae					
11.	Spreektoon en taalgebruik					
12.	Klasbelang= stelling					
13.	Klasdeelname					
14.	Samevatting					
15.	Werkopdrag					
16.	Proefjoernaal					

Opmerkings

17. Algemene opmerkings: ....
....
....

1	Baie goed
2	Goed
3	Gemiddeld
4	Swak
5	Druip

....
Handtekening

VORM K
FORM

UNIVERSITEIT VAN
UNIVERSITY OF PORT ELIZABETH

PRAKTIESE ONDERWYS

PRACTICAL TEACHING

Dosent se verslag oor student / Lecturer's report on student

STUDENT: Mnr./Mej./Mev. .... Groep:
Mr/Miss/Mrs Group:

HOD	HED
DSO	DSE
OD	ED

SKOOL/SCHOOL: ....

VAK/SUBJECT: .... **LESONDERWERP / LESSON TOPIC** ....

STANDERD / STANDARD : .... **DATE / DATUM** : ....

TAALMEDIUM/ LANGUAGE MEDIUM: .... **DURATION/TYDSDUUR** ....

	Punte uit/ Marks out of	
	10	
A. Lesvoorbereiding/Lesson preparation (Doelstellings, voorbereiding van leerinhoud en onderrigmetodes, gehalte van joernaalwerk/Aims, preparation of subject matter and methods, quality of record book)		
B. Actualization of lesson/Ontvouing van les I. Inleiding/Introduction		
2. Presentation and conclusion of lesson/ Aanbieding en afsluiting (adaptation to class level, command of subject matter, logical develop= ment use of teaching methods, con= solidation of subject matter / aanpas- sing by die vlak van die leerlinge, beheersing van leerinhoud, logiese verloop, onderrigmetodes, kon= solidering van leerinhoud)		
3. Leerlingaktiwiteit/Class activity (deelname gedurende en na aanbieding, individuele en/of groepbydrae/ participation during and after presentation, individual and/or group work)		
4. Teaching aids / Hulpmiddels (Quality, suitability and application / Gehalte, geskiktheid en aanwending)		
5. Skrvfbordwerk/Chalkboard work (Netheid, uiteensetting, logiese ontplooiing en aanwending / neatness, layout, logical develop= ment, integration)		
TOTAAL/TOTAL (%)		

	Punte uit/ Marks out of	
	10	
6. Quality of speech and voice/ Taalgebruik en Stembeheer (tone, clarity, accent, speech mannerisms, appropriateness of language/ stemtoon, helderheid, aksent, spreekgewoontes, korrekte taal=gebruik)		
7. Toepassing/Application (Gehalte van verdere opdragte en leerling=betrokkenheid/Quality of additional assignments and pupil involvement)		
8. Success in achievement of aims/ Suksesvolle lesaanbieding en be=reiking van doelstellings (level of sustained interest, retention and understanding of new subject matter by pupils / Volgehoue belangstelling, begrip en behoud van leerinhoud deur die leerlinge)		
C. PERSOONLIKHEID / PERSONALITY (Self=vertroue, entoesiasme, aanmoediging, handhawing van klasdissipline / confi=dence, enthusiasm, encouragement, ability to maintain class discipline)		
Totaal/Total (%)		

Matters needing special attention/ Sake wat aan=dag moet geniet

....

....

OPMERKINGS / REMARKS

....

....

....

....

SIGNATURE / HANDTEKENING ....

VORM L_1

VERTROULIK

RANDSE AFRIKAANSE UNIVERSITEIT

FAKULTEIT OPVOEDKUNDE

Tel. 44-7151
Posbus 524
JOHANNESBURG

WAARNEMINGSBESOEKE VAN STUDENTE AAN SKOLE

Vertroulike verslag deur die Skoolhoof in oorleg met betrokke VAKONDERWYSERS

Stuur asseblief so gou moontlik terug aan die Dekaan, Fakulteit Opvoedkunde, by bostaande adres.

LET WEL: Hierdie vorm word voltooi ten opsigte van studente wat slegs vir waarneming by u skool was en wat nog geen onderrig in onderwyspraktyk ontvang het nie. Dit geskied in ooreenstemming met die vereistes wat deur die TOD gestel word met betrekking tot onderwysersopleiding. Die verslag sal gevolglik slegs u algemene indruk weerspieël.

NAAM ....

KURSUS: (BV. SOD) ....

TYDPERK: Vanaf .... tot ....

AANTAL DAE AFWESIG ....

IS U HIERIN GEKEN? ....

Maak asseblief ten opsigte van die volgende 'n skatting op 'n vyfpuntskaal: A - Baie goed, B - Goed, C - Redelik, D - Swak, E - Baie Swak. (Lewer ook kommentaar indien nodig).

1. Belangstelling en entoesiasme vir die onderwys: ....

   ....

2. Betroubaarheid in uitvoering van opdragte: ....

   ....

3. Bereidwilligheid om te help: ....

   ....

4. Algemene houding teenoor hoof en personeel: ....

   ....

5. Vermoë om met leerlinge kontak te maak: ....

   ....

6. Kennis van vak(ke): ....

   ....

7. Dui hier u globale indruk van die student as aspirant-onderwyser aan met behulp van dieselfde vyfpuntskaal.

Algemene indruk: __________

---

8. Meld enige spesiale tekortkoming(s) by die student waarvan u meen dat ons kennis behoort te dra: ....
....
....
....
....

9. Verdere kommentaar, indien enige: ....
....
....
....
....

SKOOL: ....

ADRES: ....
....
....

TEL. NR.: ....

HANDTEKENING VAN HOOF: ....

DATUM: ....

FORM L_2

RANDSE AFRIKAANSE UNIVERSITEIT

ONDERWYSPRAKTYK

Leswaarnemingsverslag (eerste proefonderwyservaring)

Waargeneem deur: .... Datum: .... Tyd: ....
Standerd: .... Aantal leerlinge: .... Opstelling van klas: ....
Vakgebied: .... Onderwerp: ....

---

1. Hoe begin die les?
   - ☐ deur 'n opdrag van die onderwyser (vraag, probleemstelling, ens.)
   - ☐ deur 'n vraag van die leerling(e)
   - ☐ deur 'n versoek van die onderwysers (Maak .... op bls. ....)
   - ☐ enige ander wyse (beskryf) ....

---

2. Sluit die les aan by 'n vorige situasie of is dit hoofsaaklik selfstandig?
   - ☐ dit sluit aan by 'n vorige situasie
   - ☐ dit is hoofsaaklik selfstandig

---

3. Probeer so duidelik moontlik beskryf wat na u mening die doel met die les is: ....
   ....

---

4. Leerinhoud: Word van handboeke gebruik gemaak?
   - ☐ Ja – boek/oefeninge/opdragte: ....

   Hoe vul die onderwyser die leerinhoud aan?

   ☐ deur vertelling/verhaal ☐ instruksie/verduideliking ☐ demonstrasie

   Dra die leerlinge ook by tot die leerinhoud?

   ☐ Nee ☐ Baie min ☐ Grootliks

---

5. Watter onderwys- en leermiddele word gebruik? — Dra dit by tot die doelbereiking?

	Dra dit by tot die doelbereiking?
☐ Handboeke	☐ ja nee
☐ Skryfbord	☐ ja nee
☐ Truprojektor	☐ ja nee
☐ Rolprent	☐ ja nee
☐ Modelle	☐ ja nee
☐ Skuifies/strookfilm	☐ ja nee
☐ Plate	☐ ja nee
☐ Gebruiksmateriaal	☐ ja nee
☐	☐ ja nee
☐	☐ ja nee
☐	☐ ja nee

---

6. Op watter wyse laat die onderwyser die leerlinge deelneem aan die onderwys/leergebeure?

Optrede van Onderwyser	Optrede van leerlinge
☐ deel mee	....
☐ gee opdrag	....
☐ vra vrae	....
☐ stel probleme	....
☐ lok vrae uit	....
☐ daag uit	....
☐ rig versoeke	....

6. (vervolg)
- ☐ wek twyfel ....
- ☐ roep ervaringe op ....
- ☐ ....
- ☐ ....

---

7. Opmerking t.o.v. die tydsindeling van die les. Watter fases kan in die lesverloop onderskei word? ....
....

---

8. Hoe bepaal die onderwyser die leersukses van die leerlinge?
- ☐ deur skriftelike toepassing
- ☐ deur denkvrae
- ☐ deur geheuevrae
- ☐ deur nasien van huiswerk
- ☐ deur praktiese opdragte
- ☐ ....
- ☐ ....

---

9. Wat het u uit dié leswaarneming geleer?
....
....

FORM L_3

RANDSE AFRIKAANSE UNIVERSITEIT

PRAKTIESE ONDERWYS: LESVERSLAG

Student: Mnr./Mev./Mej.: .... Skool: ....

St.: .... Datum: .... Vak: .... Medium: ....

Tema: .... Doel met les: ....

....

1. Geslaagdheid van die wek en rig van leerintensie aan die hand van:

(a) Konteksbepaling. : A : B : C : D : E :

(b) Aansluiting by bestaande kennis en ervaring. : A : B : C : D : E :

(c) Aandui van lesverloop (verduidelik, eksperimenteer, probleemoplossing, ens.) : A : B : C : D : E :

(d) Die gerigtheid van die leerlinge op dit wat geleer moet word. : A : B : C : D : E :

Verdere kommentaar: ....

....

2. Onderrig:

(a) Helderheid : A : B : C : D : E :

(b) Volgorde (logiese opbou) : A : B : C : D : E :

(c) Instandhouding van leerintensie : A : B : C : D : E :

(d) Deduktief : A : B : C : D : E :

(e) Induktief : A : B : C : D : E :

(f) Aanskouing : A : B : C : D : E :

Verdere kommentaar: ....

....

3. Begeleiding:

(a) Individualisering : A : B : C : D : E :

(b) Sosialisering : A : B : C : D : E :

(c) Bemoediging : A : B : C : D : E :

(d) Remediëring : A : B : C : D : E :

Verdere kommentaar: ....

....

4. Evaluering:

(a) Soepelheid van optrede (soos blyk uit interpretasie van leerlingreaksie) : A : B : C : D : E :

(b) Bevestiging van leersukses van leerlinge : A : B : C : D : E :

(c) Formele evalueringwyse : A : B : C : D : E :

Verdere kommentaar: ....

....

5. Algemene kommentaar:

(a) Ordelike Verloop: ....

(b) Inskakeling van hulpmiddels: ....

(c) Taalgebruik: ....

(d) Persoonlike optrede: ....

(e) Gehalte van skriftelike voorbereiding: ....

EVALUERINGSPUNT: $\frac{\quad}{10}$

....

DOSENT

FORM M

UNIVERSITEIT VAN STELLENBOSCH

FAKULTEIT VAN OPVOEDKUNDE

VORM VIR DIE BEOORDELING VAN 'N PROEFLES

Naam van Student: ....

Skool: .... Klas: ....

Vak: .... Datum: ....

Onderwerp: ....

Aanwysings: Dui asseblief op elke waarderingskaal u indruk met 'n kruisie (X) aan. Die ruimte onder elke waarderingskaal is gelaat vir aanvullende kommentaar. Die syfers op die waarderingskale moet as volg vertolk word:

0–2 = Hopeloos swak, hoegenaamd niks in sy guns te sê nie,
3 = Baie swak, maar tog iets in sy guns te sê.
4 = Teleurstellend, te veel onnodige foute.
5 = Nie heeltemal bevredigend nie.
6 = Bevredigend, middelmatig, voldoen net-net aan vereistes.
7 = Goed, min noemenswaardige swakhede.
8 = Puik, uitstekend, ver-bogemiddeld.
9–10 = Volmaak of byna-volmaak.

I Voorbereiding:

0	1	2	3	4	5	6	7	8	9	10

Geheel en al onvoorbereid	Nie deeglik genoeg voorberei nie.	Toonbeeld van deeglikheid

....

....

II Planmatigheid – met stap-vir-stap uitbouing van die les.

0	1	2	3	4	5	6	7	8	9	10

Onsamehangend Planloos	Nie end-uit 'n mooi samehang en volgorde nie	Pragvoorbeeld van planmatige uiteensetting

....

....

III Tydsberekening: Te vinnig of te stadig; halsoorkop of sloer.

0	1	2	3	4	5	6	7	8	9	10

Tyd hopeloos onoordeelkundig gebruik	Tyd meesal nie reg gebruik nie	Volmaakte tydsberekening van stap tot stap

....

....

IV <u>Leerlingbelang:</u> Motivering.

0 1 2 3 4 5 6 7 8 9 10

Leerlinge verveeld en teensinnig	Nie genoeg gedoen om leerlinge te wen nie	Leerlinge end-uit geboei en tot in= spanning beweeg

....

....

V <u>Leerling-selfwerksaamheid:</u> Mate van deelname deur die leerlinge.

0 1 2 3 4 5 6 7 8 9 10

Leerlinge volkome passief end-uit	Leerlinge net in geringe mate aktief	Optimum leerling= deelname pragvoor= beeld van aktief leer

....

....

VI <u>Aanskoulikheid:</u> Oordeelkundigheid van gebruik van die swartbord en ander hulp= middels.

0 1 2 3 4 5 6 7 8 9 10

Hoegenaamd geen poging tot aanskou= likheid nie	Probeer maar ge= bruik die swart= bord en ander hulp= middels nie doel= treffend nie	Treffende illustre= ring. Vol planne i.v.m. aanskoulik= heid

....

....

VII <u>Indiwidualisering:</u> Strewe om elke leerling te bereik en te betrek.

0 1 2 3 4 5 6 7 8 9 10

Toon geen sin vir kontak met die leerlinge as indi= vidue nie	Nie genoeg probeer om elke leerling te bereik nie, soms leerlinge laat voel dat hulle "vergeet" is	Laat elke leerling voel dat hy as individu geken en gekonsidireer word

....

....

VIII Stemming in die klas:

0 1 2 3 4 5 6 7 8 9 10

Geheel en al onheilsaam; die les 'n grap of 'n stryd	Kon nie juis 'n mooi balans vind tussen werkerns en aangenaamheid nie; bietjie te swaar of te ligsinnig	Pragvoorbeeld van heilsame werkstemming. Leerlinge oorgehaal maar sonder afbrekende spanning

....

....

IX Optrede - voor die klas.

0 1 2 3 4 5 6 7 8 9 10

Dooierig verby of abnormaal onseker; gespanne en verwaaid	Mooi probeer, maar het nie genoeg selfvertroue nie; word maklik van stryk gebring; of te dominerend, ens.	Wakker, lewendig, vol selfvertroue, spontaan, natuurlik. In alles korrek

....

....

X Voordrag en Taalgebruik (Eerste taal/Tweede taal).

0 1 2 3 4 5 6 7 8 9 10

Uiters swak en onbeholpe	Het swakhede wat maklik verwyder kan word, bv. praat te sag, te eentonig, soek nog te veel na woorde, nog te onverskillig oor sy taal	Treffende uitdrukkingsvermoë, verfynde taalgebruik

....

....

GLOBALE INDRUK

0–2: Die les 'n volkome mislukking.
3–4: 'n Baie swak les, net hier en daar ietsie in die guns daarvan te sê.
5: Nie juis 'n mislukte les nie, maar in meeste opsigte onbevredigend.
6: 'n Bevredigende les, maar nie juis 'n goeie les nie.
7: 'n Goeie les, met min noemenswaardige tekortkomings.
8: 'n Buitengewoon suksesvolle les, 'n skitterende prestasie.
9–10: Volmaakte of byna volmaakte les.

....

....

....

....

Get: ....

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HSRC PUBLICATIONS SINCE 1 JULY 1975

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