SCHOOL MATHEMATICS IN SUDAN

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ABSTRACT

School Mathematics in Sudan was subjected to major changes in 1970 when the educational pattern was changed from four years at each level (Elementary, Intermediate and Secondary) to six years at the Elementary Level with three years in each of the remaining levels, and in 1974 when the decision to introduce modern mathematics was taken.

Chapter One deals with the educational background in Sudan, in particular the situation with regard to the mathematics curriculum. There is also a short description of international trends in mathematical education.

In Chapter Two, a comparison is drawn between the traditional and modern programmes at the Elementary Level, based on evaluative tests taken by pupils at the end of their Elementary School career.

In Chapter Three, two remedial projects are described, together with their evaluation in Sudan and Scotland.

In Chapter Four, the implications of the results of the study are discussed and some suggestions made to alleviate the problems encountered in Sudan.

Declaration

This thesis is my own work. I have not submitted it, or any part of it, in a previous application for a degree.

PREFACE

The research described in this thesis was conducted under the supervision of Dr. J.W. Searl and Dr. D. Monk, Department of Mathematics, and Mr. A.B. Pollitt, Department of Education.

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CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND

1.1.1 The Organisation of Sudanese Schools

Until 1970 the pattern of the educational system in Sudan was four years for the Elementary Level, the Intermediate Level and the Secondary Level. Thereafter, it was changed to six years for the Elementary Level and three years for each of the other levels. Children usually begin school at age seven. Transference from one level to the next is subject to passing national examinations. Education in the Sudanese schools is mainly non-vocational; there is a small number of commercial, technical and agricultural colleges/schools whose entrants, like the ordinary secondary schools, are those who have successfully completed the Intermediate Level. Recently, a new type of elementary schools, still under trial, have been opened. These schools are called Integrated Rural Education Centres and are geared towards rural education. They also provide informal adult education in the evenings.

All schools in Sudan are now state schools. In the past there were private intermediate and secondary schools, but these were taken over by the government because their standards were very low in comparison with the state schools. However, since 1970 the government has been encouraging the citizens to co-operate to build 'self-help' schools with their own money. The government supplies these schools with the administrative staff, teachers and books. So these schools are recognised as state schools. 'Self-help' for building schools, health centres etc. has become a state policy.

Before 1970 people had to pay fees for their children in the Intermediate and Secondary Levels, but at present, education is free in the three levels although it is not compulsory.

Boys and girls are segregated in the intermediate and secondary schools. In the Elementary Level the schools are mostly segregated but in some areas, especially the villages, there are mixed schools. Class sizes in the intermediate and secondary schools vary from 40 to 70 pupils. In the elementary schools the size is up to 100 pupils. Women teachers are only found in girls' schools, whereas men teachers are found in mixed elementary schools and in intermediate and secondary girls' schools. In each level the ratio of the number of girls to the number of boys is approximately 2:5.

Bells are rung for the beginning of the school day and for the beginning and finishing of each period. The classes begin at 8 a.m. and finish at 1.30 p.m. in the Elementary Level, and at about 2 p.m. in the other two levels. The length of the period is 40 minutes.

Everyday at 7.40 a.m. all the elementary and intermediate school pupils stand in lines in the school yards and the masters on duty speak to them giving instructions and notices. At 7.45 a.m. the pupils sing the 'flag salute' which is the republican salute of the state. Then the pupils quietly enter their classrooms in queues.

It is traditional in all levels that when the teacher enters the classroom all the pupils stand up. When the teacher is sure that everybody is standing upright, he or she salutes them by saying 'peace be upon you'. The pupils reply similarly.

1.1.2 Teacher Training

Formal teacher training in Sudan began in 1934 when the Institute of Education, Bakht Er Rida, was established. This institute was founded by Mr V.L. Griffiths, a British expert in teacher training who was appointed a principal of the institute. [For more information about Mr Griffiths, see Bashir M.O., 'Educational Development in the Sudan (1898-1956)', Clarendon Press, Oxford, 1969.] The institute started as a training centre for the elementary school teachers. In 1949 its work was extended to train intermediate school teachers when a centre for this purpose was established. There are now other training centres for the elementary school teachers in the different parts of the country. Bakht Er Rida is responsible for the supervision of these centres. There are also other training centres for the intermediate school teachers in Omdurman. Most of the teachers for the secondary schools and the teacher training institutes are trained in the Faculty of Education at the University of Khartoum, which was established in 1961.

Entrants to the Elementary School Level Teacher Training Institutes must have completed the Intermediate School Level successfully. The student teachers spend four years in these institutes. The entrants to the Intermediate School Level Teacher Training Institutes will have completed the Secondary School Level successfully and have worked as intermediate school teachers for more than two years. The institute at Bakht Er Rida provides a one-year course, while those in Omdurman provide a two-years course. In each institute the specialisation is in two subjects. Another source for training the intermediate and elementary school teachers is the In-Service Educational Training Institute (ISETI). This institute only provides initial (basic) teacher training. It serves men and women who have successfully completed their secondary schooling and who were recruited as teachers in the Elementary and Intermediate School Levels directly without any training.

ISETI is located in Khartoum, but has branches in some parts of the country. The Institute is concerned with training only those teachers whose schools lie in the catchment area of one of its branches. The training consists of assignments carried out by the teachers in their schools and of lectures once or twice a week in the branch buildings. This course lasts for two years. Elementary school teachers whose schools are not in the catchment areas of the branches of the ISETI are trained by the Elementary Teacher Training Section of the Ministry of Education and Guidance. The training of these teachers takes place in two phases each of two months duration. There are centres in the country for this type of training.

All types of training for the intermediate and elementary school teachers have certain weaknesses. The one-year or two-years course for training the intermediate school teachers is too short, especially for a mathematics teacher. This criticism is also applicable to the training courses provided by the ISETI. Moreover, the quality of the training provided by the Institutes may not be sufficient to change attributes acquired by the untrained teacher while teaching without adequate affective and cognitive preparedness.

The inadequacy of the training provided in two phases each of which lasts only two months is self-evident. The weakness of the Elementary School Level Teacher Training Institutes is their curriculum content. The textbooks used in these institutes are those used in the secondary schools, despite the fact that the goals for teaching mathematics in the secondary schools are different from those for teaching mathematics to prospective elementary school teachers.

1.1.3 School Mathematics in Sudan

The Institute of Education, Bakht Er Rida, established the pattern of curricula development in Sudan. Since its establishment, Bakht Er Rida had been responsible for preparing the curricula and textbooks for the Elementary and Intermediate Levels. In 1970 its function was reduced to teacher training only, but in 1974 it was restored to its previous position. Now Bakht Er Rida is considered as an institute in which research is taking place on curricula development for the three levels as well as a training centre of the elementary and intermediate school teachers.

The main constituents of Bakht Er Rida are twelve departments, two training centres, a unit for Integrated Rural Education Centres (IRECS) and a centre for educational research. Of the twelve departments, seven are major academic departments specialised in different subjects. The pattern adopted at Bakht Er Rida in preparing the textbooks has been to test them for two years and then revise them according to the outcome of the trials. There are six elementary schools and three intermediate schools attached to Bakht Er Rida which serve the purpose of carrying out trials and teacher training.

Like other major departments, the Department of Mathematics is responsible for:

1. formulating curricula and designing syllabuses of mathematics for:
   a) the Intermediate and Elementary Teacher Training Centres,
   b) the elementary, intermediate and secondary schools;
2. writing the pupils' mathematics textbooks with their respective teacher guides;
3. setting the final National Mathematics Examinations for the Intermediate Level, the Intermediate Training Centre and the Elementary Training Centres in the different parts of the country;

(The department had been responsible like other major departments, for setting the final National Mathematics Examinations for the Elementary Level. In 1982 this responsibility was transferred to the education centres in the different regions of the country.)

4. training the mathematics prospective teachers for both elementary and intermediate schools.

In the 4-4-4 pattern the secondary school mathematics was taught in English. The textbooks for this level were not written in Sudan until 1970. The Sudanese Ministry of Education imported the textbooks from England. There were three textbooks, for arithmetic, algebra and geometry, each of which covered the syllabuses for the four years in the Secondary Level. In addition to these, there was a small trigonometry textbook. These books were written by Durell according to the University of Cambridge requirements. In the fourth year of the Secondary Level the students used to be divided into two sets. The most talented in mathematics were advised to take additional mathematics, the syllabus of which contained elementary calculus, analytic geometry, advanced sections from the Durell's books and trigonometric identities.

In 1970 the 4-4-4 pattern was abandoned and the 6-3-3 pattern was adopted. Concurrently a curriculum section for the Secondary Level was formed in Khartoum. This section took over responsibility of preparing textbooks for the Elementary and Intermediate Levels. The mathematics group in this section has changed the secondary mathematics curriculum and syllabuses and written the textbooks in Arabic. The following picture shows the changes that the mathematics group has done in the syllabuses of the three levels. The arrows show that the same books were transferred from forms in the old pattern to the corresponding forms in the new pattern.

		4-4-4 pattern		6-3-3 pattern		
Elementary Level	1	Only Teacher Guide	→		1	Elementary Level
	2	Text Book and Teacher Guide	→		2	
	3	Text Book and Teacher Guide	→		3	
	4	Text Book and Teacher Guide	→		4	
Intermediate Level	1	Text Book and Teacher Guide	→		5	
	2	Text Book and Teacher Guide	→		6	
	3	Text Book and Teacher Guide	→		1	Intermediate Level
	4	Text Book and Teacher Guide	→		2	
Secondary Level	1	Durell's Books	→	translated	3	
	2	Durell's Books	→	translated and other books	1	Secondary Level
	3	Durell's Books	→	translated and other books	2	
	4	Durell's Books	→	translated and other books	3	

From the diagram above, it can be seen that the mathematics group prepared different textbooks for the Secondary Level. They translated their materials from different English books covering the material of Durell's books. In addition to the translated materials they added to the syllabuses some topics from the Egyption secondary mathematics textbooks which are written in Arabic. Also, they translated and added topics previously taught in the preliminary year of the University of Khartoum. Thus the Secondary Level mathematics syllabuses have been expanded a great deal.

The adoption of the pattern 6-3-3 was accompanied by the setting of the students into two divisions in the second and third year at secondary schools. These were the science division and the arts division. The placing of a student in either of the two divisions was based on his or her performance in mathematics and science, combined in the examinations at the end of the first year. The science division students who obtained the highest grades in mathematics in the final examination at the end of the second year would be chosen to take 'special mathematics' in the third year in addition to the ordinary syllabus of the science division.

The following diagram shows the mathematics syllabus in the Secondary Level:

First year general 6 periods/week	Algebra, Euclidean geometry, Trigonometry
Second year arts 3 periods/week	Algebra, Euclidean geometry, Analytic geometry
Second year science 7 periods/week	Algebra, Euclidean geometry, Analytic geometry, Trigonometry, Statistics, Determinants
Third year arts 3 periods/ week	Algebra, Euclidean geometry, Analytic geometry
Third year science 6 periods/week	Algebra, Analytic geometry, Statistics, Calculus, Trigonometry
Third year special maths (6+5) periods/week	Algebra, Analytic geometry, Calculus, Mechanics

The policy adopted by the mathematics group was not sound. First, the syllabus adopted for the new third year in the Intermediate Level was taken from the old first year in the Secondary Level which was designed for those who passed the Secondary Level Entrance Examinations and not for every pupil in the Intermediate Level. So there were many complaints from the third year Intermediate teachers that their pupils found the material too difficult. In the same way the text-books which had been originally assigned for second and first year in the Intermediate Level were not appropriate for the sixth and fifth year in theElementary Level. These two books were written for those who could enter the Intermediate Level. Again, the elementary school teachers were complaining that these two books were too difficult for the pupils. Second, the mathematics group gathered the Secondary Level syllabuses from different sources without regard to the background of the students. The new syllabuses were not subjected to trials by the mathematics group.

1.2 THE MODERN MATHEMATICS TREND

1.2.1 The International Movement

The importance of mathematics for man's intellectual development and his exploitation of resources is unquestionable. As a utilitarian body of knowledge, the mathematical skills and techniques taught in schools, satisfy the broad needs of industry, business and commerce. They also enable the individual to cope with everyday situations and solve everyday problems. As a formative body, the abstract nature of mathematics meets the needs of the society by developing the individual's capacity for thought and his ability to reason logically and assess the reasoning of others. For these reasons all societies in the modern world are very concerned about the mathematical achievement of their students.

The study of mathematics is an international activity. Any development in the subject will be adopted by all the countries of the world. So it is not surprising that the recent movement for modernising the mathematical curricula is a world-wide movement. This movement began towards the end of the 1950's. During the 1960's extensive educational research was undertaken in preparation for the modernisation of mathematics curricula. Many groups were formed for this purpose, such as the School Mathematics Study Group in the USA and the School Mathematics Project in Britain. During the 1970's the new curricula were introduced.

The trend of modern mathematics became world-wide. The USA funded Educational Services Incorporated sponsored the African Mathematics Program (1961-70) which designed complete courses for African countries. Similarly, UNESCO launched a mathematics project for the Arab States in 1969 (Flemming, 1980).

Because more emphasis was placed on understanding, the computational skills received less emphasis in the new programmes. This change was a result of the suggestions of the Cambridge Conference 'Goals for School Mathematics' (1963). This also recommended a reasonable acquisition of computational and algebraic manipulation, but this recommendation was overlooked by the developers (Blij _et al_., 1981). In the 1970's people became aware of the deficiences of the new curricula. There were complaints that the pupils' attainment had deteriorated. Borg and Gall (1979), however, ascribed the low standard of the students following the new programmes in comparison with those following the traditional ones to the biased setting of the tests used. These tests, they claimed, were valid for the traditional programmes rather than the new ones. However, the new curricula were revised.

1.2.2 Sudanese Innovations

Under the influence of Islamic Arab culture, modern Arab nationalism, the underlying common interests and the 'demands of social and economic development, the Arab States have tried to unify their education goals' (Jurdak and Jacobsen, 1981). Jurdak and Jacobsen stated that at the Elementary Level, 'the main changes have involved the placement, the sequence and the organisation of topics', and 'Sudan has revised its programme in the elementary mathematics ...' accordingly. At the Intermediate Level, 'in some cases, the Arab League Educational, Scientific and Cultural Organisation Mathematics Project for intermediate schools has been the starting point. In others, countries have started their own national efforts ..... An up-dated programme has been implemented in all intermediate schools in Sudan after three years experiment' (Jurdak and Jacobsen, 1981).

At the Fourth International Congress of Mathematical Education, Nebres (1980) criticised traditional mathematics for making things look magical. He pointed out that in 'addition' children learned 'carrying' by rote memorisation without understanding. In contrast, he also remarked that spending too much time explaining the logical procedures would leave no time for the children to acquire skills. He criticised the call for 'return-to-basics' and asserted that it must not imply a return to learning by rote without understanding, but it should be a call for a balance between the 'why' and the 'how'. This was the aim of the curriculum developers in Sudan in 1974 when they embarked on designing the modern mathematics programmes for the elementary and intermediate schools.

In 1974 Bakht Er Rida resumed responsibility for formulating curricula and writing textbooks for the elementary and intermediate schools. At that time the Minister of Education took the decision to introduce modern mathematics in the elementary and intermediate schools and the Department of Mathematics at Bakht Er Rida was told to implement the decision. The modernisation of the intermediate school textbooks was accomplished in 1979, and that of the elementary textbooks was completed in 1982.

The modern programme, in Sudan, can be defined, in contrast with the traditional one as follows. The modern programme is that in which the treatment of the subject matter emphasises the basic structure of mathematics but does not neglect the computational skill, while the traditional programme is one in which the treatment of the subject matter emphasises the computational skill rather than the basic structure of mathematics.

To make the change as smooth as possible the content of the syllabus at the Elementary Level was unchanged. However, the approach to the subject matter was changed, using modern terms such as the 'identity element of multiplication' and the 'multiplicative inverse' and concentrating on logical steps. For illustration, division and simplification of common fractions are good examples.

In the lesson about division of common fractions the pupils following the traditional programme were just told that to divide a common fraction by another they should interchange the numerator and denominator of the divisor and then multiply the numerators and denominators. It was not explained to them why this works. In the modern programme this is illustrated to the pupils by a sequence of logical steps using the properties of the 'identity element of multiplication' and the 'multiplicative inverse', and the fact that multiplication and division are inverse operations (i.e. for $a \neq 0$, $c = a \times b \Longleftrightarrow \frac{c}{a} = b$)*, for example, to evaluate:

$\frac{3}{4} \div \frac{2}{3}$ the process is explained as:

$\frac{3}{4} = 1 \times \frac{3}{4}$ (identity element of multiplication).

But $\frac{2}{3} \times \frac{3}{2} = 1$ (multiplicative inverse).

Therefore $\frac{3}{4} = \frac{2}{3} \times \frac{3}{2} \times \frac{3}{4} = \frac{2}{3} \times (\frac{3}{2} \times \frac{3}{4})$ (associative property)

$$= \frac{2}{3} \times \frac{9}{8}$$

So, since $\frac{3}{4} = \frac{2}{3} \times \frac{9}{8}$, then, using * above, it follows that

$$\frac{3}{4} \div \frac{2}{3} = \frac{9}{8}$$

$$= \frac{3}{2} \times \frac{3}{4}$$

$$= \frac{3}{4} \times \frac{3}{2} \quad \text{(commutative property).}$$

Of course, the drills are not worked out like that. The pupils are just convinced that the idea of interchanging the numerator and denominator works. Therefore, they acquire this skill and just apply directly the idea knowing why it works.

The lesson of simplification of common fractions was taught in the traditional programme without giving the pupils any explanation to understand the process of cancelling the factors. For example, the pupils could simplify the fraction

$\frac{6 \times 7}{15 \times 35}$ easily as:

$$\frac{{}^{2}\not{6} \times \not{7}^{1}}{{}_{5}\not{15} \times \not{35}_{5}} = \frac{2}{25}$$

But it was common to find simplifications of fractions like $\frac{6 + 7}{15 \times 35}$ as

$\frac{{}^{2}\not{6} + \not{7}^{1}}{{}_{5}\not{15} \times \not{35}_{5}} = \frac{3}{25}$, which reflects misunderstandings.

Even in the Secondary Level it was common to come across behaviour like this:

$$\frac{{}^{1}\not{2}X + 1}{{}_{1}\not{2}Y - 7} = \frac{X + 1}{Y - 7}$$

To solve this problem, in the modern programme the pupils are taught that simplification of a common fraction by cancelling the factors should result in an equivalent fraction, and this result cannot be obtained unless the operations involved in the fraction to be simplified are only multiplication and division (i.e. only these two inverse operations).

At the Intermediate Level, most of the content of the traditional programme was unchanged, and some of the modern topics such as number systems, sets, relations and functions were introduced. But the old content is tackled differently in the modern programme by concentrating on showing the pupils why a rule works. For example, the pupils following the traditional programme were taught to learn by rote, without any illustration, that multiplying any number by zero gives zero, multiplying a negative number by a positive number gives a negative number and multiplying a negative number by a negative number gives a positive number. The modern programme gives a convincing illustration to the pupils. A formal proof is not given at this level because it is beyong the mental capacity of the pupils. Such an illustration might be:

I	II	III	IV
$3 \times 2 = 6$	$2 \times (-3) = -6$	$\frac{5}{2} \times \frac{1}{2} = \frac{5}{4}$	$\frac{5}{3} \times (-\frac{1}{4}) = -\frac{5}{12}$
$2 \times 2 = 4$	$1 \times (-3) = -3$	$\frac{4}{2} \times \frac{1}{2} = \frac{4}{4}$	$\frac{4}{3} \times (-\frac{1}{4}) = -\frac{4}{12}$
$1 \times 2 = 2$	$0 \times (-3) = ?$	$\frac{3}{2} \times \frac{1}{2} = \frac{3}{4}$	$\frac{3}{3} \times (-\frac{1}{4}) = -\frac{3}{12}$
$0 \times 2 = ?$	$(-1) \times (-3) = ?$	$\frac{2}{2} \times \frac{1}{2} = \frac{2}{4}$	$\frac{2}{3} \times (-\frac{1}{4}) = -\frac{2}{12}$
$(-1) \times 2 = ?$	$(-2) \times (-3) = ?$	$\frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$	$\frac{1}{3} \times (-\frac{1}{4}) = -\frac{1}{12}$
$(-2) \times 2 = ?$	$? \times (-3) = ?$	$0 \times \frac{1}{2} = ?$	$0 \times (-\frac{1}{4}) = ?$
$? \times ? = ?$	$? \times ? = ?$	$(-\frac{1}{2}) \times \frac{1}{2} = ?$	$(-\frac{1}{3}) \times (-\frac{1}{4}) = ?$
		$(-\frac{2}{2}) \times \frac{1}{2} = ?$	$(-\frac{2}{3}) \times (-\frac{1}{4}) = ?$
		$? \times ? = ?$	$? \times ? = ?$

In columns I and III the pupils are guided to discover the number patterns and find out by how much the varying multiplier decreases, and by how much the result of multiplication decreases. In columns II and IV the pupils are guided to discover the number patterns and find out by how much the varying multiplier decreases and by how much the result of multiplication increases.

Formal proofs, however, are given to the prospective teachers in the training centre.

Here is another example. The identity $-(X-Y) = Y-X$ was 'proved' in the traditional programme by: $-(X-Y) = -X+Y = Y-X$, or sometimes by: $-(X-Y) = (-1)x(X-Y) = -X+Y = Y-X$ without any further explanation. These 'proofs' are unsound since on the left-hand side there is a negative number and not a multiplication operation. In the modern programme, the equality is proved by applying the definition of the additive inverse. Proof: $(Y-X) + (X-Y) = Y-X+X-Y = 0 \Longrightarrow$

$Y-X$ is additive inverse of $X-Y$. But $-(X-Y)$ is the symbol for the additive inverse of $X-Y$. Therefore, since additive inverse is unique, then $-(X-Y) = Y-X$.

1.2.2.1 The Modern Programme of the Secondary Schools

In 1978 the curricula section in Khartoum was dissolved and the responsibility of preparing the Secondary Level curricula and text-books was transferred to Bakht Er Rida. In 1979 the Minister of Education and Guidance abolished the division system in the Secondary Level. The system which had been used until 1970 has been adopted again. But the contents of the mathematics syllabuses have not been changed. Also, in 1979 the Department of Mathematics at Bakht Er Rida was told to introduce modern mathematics in the secondary schools.

In November 1979, the first conference for developing the Secondary School Mathematics was held in the University of Khartoum. The conference made a number of suggestions to the Ministry of Education and Guidance. Some of them are quoted below:

The Secondary Level is considered as the final stage for 90% of those who enter it. Therefore, the mathematics curriculum should meet the needs of the 90% who terminate their education at this level and the needs of the 10% who continue their higher education. Thus the curriculum should -

1. be integrated so that the mathematics subjects are well ordered;
2. concentrate on the understanding of the basic structure of mathematics together with the acquisition of computational skills even if this leads to cuts in the syllabuses;
3. contain the unifying concepts;
4. not neglect Euclidean geometry in the school certificate examinations;
5. contain applications of the concepts of the transformation geometry in proofs of some Euclidean geometry theorems;
6. contain solid geometry.

Unfortunately, the Department of Mathematics at Bakht Er Rida could not begin to introduce a modern programme in the secondary schools because it lacked a group whose members were well-informed in the field of mathematics education. The work of the mathematics group in Khartoum which turned out to be haphazard is evidence of the need in Sudan for development staff.

1.3 ABOUT THE STUDY

The study aimed to provide insight into the elementary school mathematics curricula, traditional and modern. It is the first study of its kind conducted in Sudan. The only previous study, by Subayr (1968), concerned the format of the mathematics achievement tests in the Sudanese intermediate schools.

In Chapter Two, a comparison is made between the traditional and the modern mathematics programme at the Elementary Level. Prior to this summative evaluation, a formative evaluation of the modern programme was carried out by a member of the Mathematics Department at Bakht Er Rida. Each year information about the progress of the trials in the Elementary and Intermediate Levels was collected.

The policy for introducing modern mathematics took a double track. In 1975, two trial books were written for the first year of the Elementary and Intermediate Level. The following year a book for the second year of each level was prepared, and so on. Each book was tested for two years before it was revised and used by all schools in Sudan. Thus, through the school years 1977-78, 1978-79 and 1979-80, the syllabuses were modernised in the first three years of the Elementary Level and all three years of the Intermediate Level throughout the country. In the following school years the syllabuses of the fourth, fifth and sixth year of the Elementary Level were modernised.

For the trial at the Elementary Level, Bakht Er Rida elementary schools (six streams), schools from the town of Dueim, the city of Khartoum and the city of Omdurman were chosen by the authorities.

The comparison of the two programmes in this study was expected to give results in favour of the modern programme. The formative evaluation was encouraging. Traditional mathematics programmes in elementary schools did not vary significantly from place to place. They all emphasised the acquisition of computational skill, ignoring to some extent, understanding of the underlying principles. In contrast, the modern programmes do vary in the degree of abstraction adopted. The more emphasis placed on abstraction in a programme, the more likely the pupils are to find that programme difficult. The success of a modern programme with a higher degree of abstraction against a traditional programme will be an indication that a programme with a lower degree of abstraction will be successful. Borg and Gall (1979) reported that comparisons of the traditional and modern programmes made using valid tests for both types of programmes showed that the modern programmes were superior to the traditional ones. As pointed out before, the modern programme for the Sudanese elementary schools does not contain modern topics, except a few modern terms, but the significant feature of the modern approach is the concentration on logical steps in presenting the subject matter. Moreover, the modern programme, unlike the traditional one, places equal emphases on understanding and acquisition of computational skill.

The study described in Chapter Two sought to answer the following questions:

1. Could the modern programme give greater help to the lower achievers?
2. Could the modern programme inspire the higher achievers to attain better in mathematics than the traditional programme could?
3. Could the modern programme give the pupils a better attitude towards mathematics?
4. Did the pupils following both programmes master computational skills equally well?

5. Which programme contributed better to algebraic thinking?

Chapter Three deals with possible ways of remedying weaknesses in the pupils' mathematical attainment indicated by the study described in Chapter Two. Two remedial projects were designed and tested. Project I is a programme of learning material and Project II is a poster teaching approach.

CHAPTER TWO

A COMPARISON OF THE TRADITIONAL AND MODERN MATHEMATICS PROGRAMMES IN THE ELEMENTARY LEVEL

2.1 METHOD

2.1.1 Sampling

The target population was the sixth year pupils of the elementary schools in the White Nile Province, the city of Khartoum and the city of Omdurman. Over the past years the results of the Elementary School Certificate in mathematics did not vary significantly from one province to another or from city to city in Sudan. Thus, this population could be considered as relevant and educationally significant.

The subjects of the selected samples were thirteen-year-old boys and girls. The schools chosen from the White Nile Province were in urban and rural districts. All the schools were well-disciplined and their mathematics teachers were considered by the authorities to be equally and sufficiently competent.

The sampling was by direct selection. The schools of the innovative programme were predetermined, having been specified by the authorities as pilot schools for the new curricula. The only role of the author was to choose the control group schools from those schools in which the traditional programme was taught. So equal numbers of the traditional programme schools in the same areas as, and equivalent in all respects to, the modern programme schools were deliberately selected.

For this study two samples were selected. The first sample was selected in the school year 1981/82 just before the pupils sat the Final National Examinations. The sample size was 1024 pupils. This included 256 'traditional boys', 267 'modern boys', 254 'traditional girls' and 247 'modern girls'. The second sample was selected at the same stage of the subsequent school year 1982/83. The sample size was 733 pupils. This included 160 boys and 222 girls from schools which were previously following the traditional programme; and 179 boys and 172 girls from schools which were previously following the trial modern programme.

2.1.2 Design of Study and Data-Collecting Procedure

Because this study did not use random assignment for comparing groups its design may be classified as 'quasi-experimental' in the terminology of Cook and Campbell (1979). Random assignment was not possible in this study, but, even if it had, it would not have been appropriate. Random assignment in school settings disturbs the routine. It also produces artificial situations which affect the behaviour of pupils. The pupils will be aware of being put in competition with other groups and this impression will have its effect on their behaviour.

In this study there were two stages. In the first stage, the sample consisted of an experimental group ('the modern pupils') and a control group ('the traditional pupils'). The two groups were post-tested (with two tests and an attitude scale) near the end of the school year 1981/82. The significance of this timing was that the pupils would have finished the syllabuses and were ready for the Final National Examinations, or any tests, from the academic and psychological point of view. In the school year 1982/83 all schools had introduced the new programme after completion of the trial stage in the previous year. In the second stage, the sample consisted of pupils from those schools which were chosen in the year 1981/82. The pupils were post-tested using the same tests as before but a different attitude scale.

In the first stage, the experimental and control group were compared. In the second stage, the pupils who sat the tests were compared with the pupils from their schools who sat the tests in the previous year. This was to validate the comparison made for the 'traditional' and 'modern' pupils in the first stage. It was also intended to discover what progress appeared after the general introduction of the new programme textbooks.

Since the design of the present study was quasi-experimental, intervening variables rather than the independent variable might account for the experimental results. The intervening variables included time of testing, skills to be acquired from the syllabus, age of pupils, discipline of schools, ability of teachers, standards of schools, intelligence of pupils and time spent on teaching the syllabus. The presence of intervening variables throughout the experiment may not be serious if they operate systematically on all groups.

Some of the intervening variables mentioned above could be controlled. The tests were administered at the same time in all the schools involved. The skills tested were known to be similar for both groups. Also as remarked by the authorities, the variables of age, school discipline, teachers' ability and standards of schools turned out to be consistent in all schools involved.

The intervening variables which might survive the experiment were intelligence of pupils and time spent on teaching the syllabus. According to the authorities, the 'traditional' schools finished the syllabus in 1982 much earlier than the 'modern' schools. This was due to complications accompanying the arrival of the 'modern' books in the trial schools. On the other hand, although intelligence was considered as a surviving intervening variable, there is no evidence available that pupils in certain districts, towns or villages in Sudan are less intelligent than others. In each school, pupils are assigned to classes on entry after being enrolled without regard to the intelligence variable. In past years the honour lists of schools and students in the Sudan School Certificate results included students and schools from all parts of the country. This suggests that the variable of pupils' ability remains consistent in all schools.

Since the tests were administered simultaneously in all schools, and the test papers were collected at the same time in all classes immediately at the end of the test, there was no chance for transmission. As described before, the pupils had just completed their preparations for examinations at the time the tests were administered. Thus, the simultaneous collection of data from all schools and the preparedness of all the pupils for the tests increased the internal validity of the study.

2.1.3 Instruments Employed

Two attainment tests, each of one hour's length, were developed. Test I covered the first half of the syllabus to be tested. It was intended to be easy so as to indicate which programme was of greater help to the low achievers. Test II covered the second half of the syllabus which contained the most difficult topics of the syllabus. Thus, this test was expected to be more difficult than Test I. Being difficult, Test II was intended to show which programme was more suited to the high achievers. Test I contained short questions, operations and verbal problems (see Appendix C). Most of the items of Test II were verbal problems (see Appendix D). Verbal problems provide information about pupils' understanding of procedures and at the same time test pupils' computational skills. These were the main attributes to be tested in this study.

The tests sought to evaluate the same skills which were part of both programmes (see Appendix E), but they could, also, discriminate between the groups (see Appendices G and H, and Figures 2.1 to 2.4 and 2.7 to 2.14). Therefore, the tests had construct validity although they did not have content validity since the two programmes had different approaches to the subject matter. But content invalidity of the tests was not a serious matter because the tests were intended to test skills and not understanding of concepts.

The marking scheme for the tests was based on the difficulty and length of each question. Each required step was assigned at least half a mark. The scores of individual items in each test are given in column two in Appendices G and H. The weights of the topics tested in the two tests together were assigned according to the importance of the topic and the number of lessons assigned to it (see Appendix F). The maximum score of each test was 50 and the 'passing' score was 25.

Also, an attitude scale was developed to be answered together with the two tests (see Appendix A). The scale and the tests were administered in two sessions. In the first session the pupils were required to complete the scale and then answer Test I. In the second session the pupils sat Test II.

In the second stage, a new attitude scale was designed using the Repertory Grid Technique developed by Duckworth and Entwistle (1974). This scale was adopted to disguise mathematics among other subjects so that the pupils might show their true attitude towards mathematics. Like the previous one, the scale was required to be completed by the pupils just before they answered Test I. The scale is shown in Appendix B.

2.1.4 Analytic Techniqes

The data were analysed graphically using frequency percent polygons and graphical item analysis. Also, facility values were computed and analysed, and illustrative diagrams were drawn and analysed. These techniques were employed because the design of the study does not satisfy the conditions for using either parametric or nonparametric statistical techniques. However, descriptive statistics can give as valuable information as statistical inference techniques which are applied in other situations.

The units of analysis chosen were individual scores, facility value and mean score for each of the groups compared in each test. Facility values are shown in Appendices G and H.

2.1.5 Results and Discussion

The score distribution in each of Figures 2.1 to 2.4 and Figures 2.7 to 2.14 is bimodal. There is a group of pupils who pass and a clearly separable group who fail. The separation between the groups falls, coincidentally, at about 50% of the maximum score. The vertical line through the point (27) shows the separation.

Figures 2.1 and 2.3 show the distributions of scores obtained in Test I in 1982 and Figures 2.2 and 2.4 show the distributions of the scores obtained in Test II. The results are summarised in Table 2.1 where the proportions of boys and girls in each group are shown.

Table 2.1

Test	Type of pupil	Proportion of pupils scoring < 25	Proportion of pupils scoring ≥ 25
I	'TD' Boys	0.40	0.60
	'MD' Boys	0.30	0.70
	'TD' Girls	0.71	0.29
	'MD' Girls	0.34	0.66
II	'TD' Boys	0.76	0.24
	'MD' Boys	0.60	0.40
	'TD' Girls	0.88	0.12
	'MD' Girls	0.71	0.29

Comments

1. In Test I, about 1/4 of the boys who would 'fail' on the traditional programme would 'pass' on the modern one, and about 1/2 of the girls who would 'fail' on the traditional programme would 'pass' on the modern one.
2. In Test II, about 1/5 of the boys who would 'fail' on the traditional programme would 'pass' on the modern one, and about 1/5 of the girls who would 'fail' on the traditional programme would 'pass' on the modern one.

The results for the various skills shown in Appendix I are summarised in Table 2.2.

Table 2.2

Skills tested	Score	Mean score of 'TD' Boys	Mean score of 'MD' Boys	Mean score of 'TD' Girls	Mean score of 'MD' Girls
A: Definition	6.5	5	4	4	4
B(1): Arith. Operations	35	19	19	13	19
B(2): Arith. Problems	20.5	8	6	4	7
C: Algebraic Thinking	29	5	10	5	6
D: Geometric Constructions	9	3	5	1	5

From Table 2.2, it is clear that the 'MD' boys are better than the 'TD' boys in algebraic thinking, whereas there is no significant difference between the two groups of girls. The total score shows that the 'modern' pupils are better overall than the 'traditional' pupils, but the 'MD' girls are very much better than the 'TD' girls.

The study of Fennema and Sherman (1977) showed no difference between the mathematical attainment of boys and girls. Later, Badger (1981), reviewing the literature comparing mathematical attainment of boys and girls, pointed out that age 13 is a turning point. Before this age there will be no significant difference between girls and boys with respect to mathematical attainment, but after 13, girls show diminishing ability in comparison to boys. It would be useful to recall that the age of pupils of the present study was 13. However, the findings of Fennema and Sherman and those of Badger might be culture-dependent.

From the results discussed above, it is clear that the 'MD' boys are at the top in attainment and the 'TD' girls are at the bottom. The 'TD' boys and the 'MD' girls occupy the intermediate places. But Table 2.2 shows that the attainments of the 'TD' boys and the 'MD' girls are not significantly different. So the concentration will be on comparing the 'TD' boys and the 'MD' girls to find out the effects of differences in programme and sex on pupils' attainment in mathematics. To do that, it is supposed that difference in sex is constantly a handicap for girls and difference in programme is being varied. This does not imply that for any boy and girl the boy is better in mathematical attainment, but it means that it is believed that an average boy performs better in mathematics than an average girl.

The difference, TB-MG, between the scores obtained by the 'TD' boys and the scores obtained by the 'MD' girls is shown in Table 2.3.

Table 2.3

Skill tested	TB-MG
A	+ 1
B(1)	0
B(2)	+ 1
C	- 1
D	- 2

The algebraic sum of the figures in the second column of Table 2.3 is -1. This indicates that being in the modern programme compensates for the handicap of being a girl and leaves an advantage.

To see whether difference in programme and sex have any effect on pupils' attainment in any arbitrary chosen set of questions, Table 2.4 was constructed.

Table 2.4

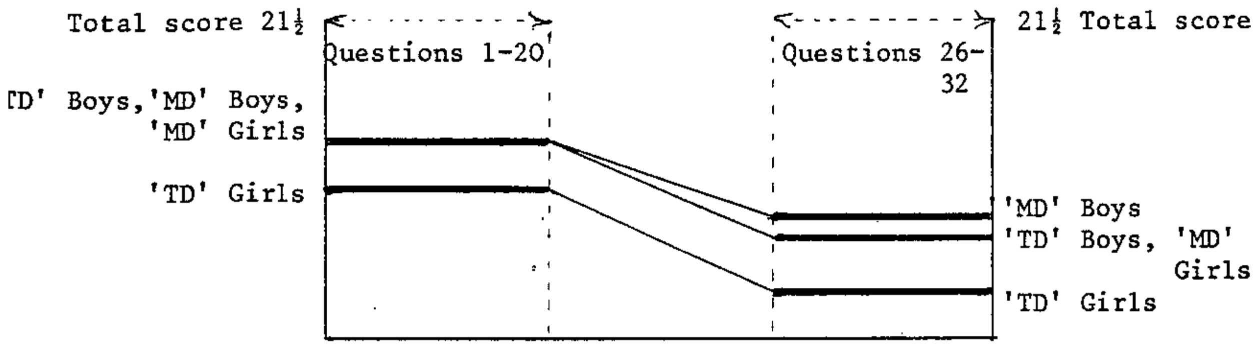
Questions		Mean score of 'TD' boys	Mean score of 'MD' boys	Mean score of 'TD' girls	Mean score of 'MD' girls
TEST I	1-20 Total score = 20.5	13	12.5	10	13
	26-32 Total score = 20.5	7	8	3	7
TEST II	1- 7 Total score = 29	10	11	7	9
	10-12 Total score = 11.5	1	5	1	2

In Test I, the 'TD' boys, the 'MD' boys and the 'MD' girls have approximately equal scores in questions 1-20, while the 'MD' boys rank first, the 'TD' boys and the 'MD' girls share the second place and the 'TD' girls rank fourth in questions 26-32. The dispersion of the four types of pupil according to the result in Test I can be illustrated by Diagram 2.1 below.

From diagram 2.1, it is clear that in the first twenty questions of Test I, the difference in programme had no effect on the boys, but had a great effect on the girls. It can be seen that being in the modern programme nullifies the advantage of being a boy. In the last seven questions, being in the modern programme compensates for the handicap of being a girl.

Diagram 2.1

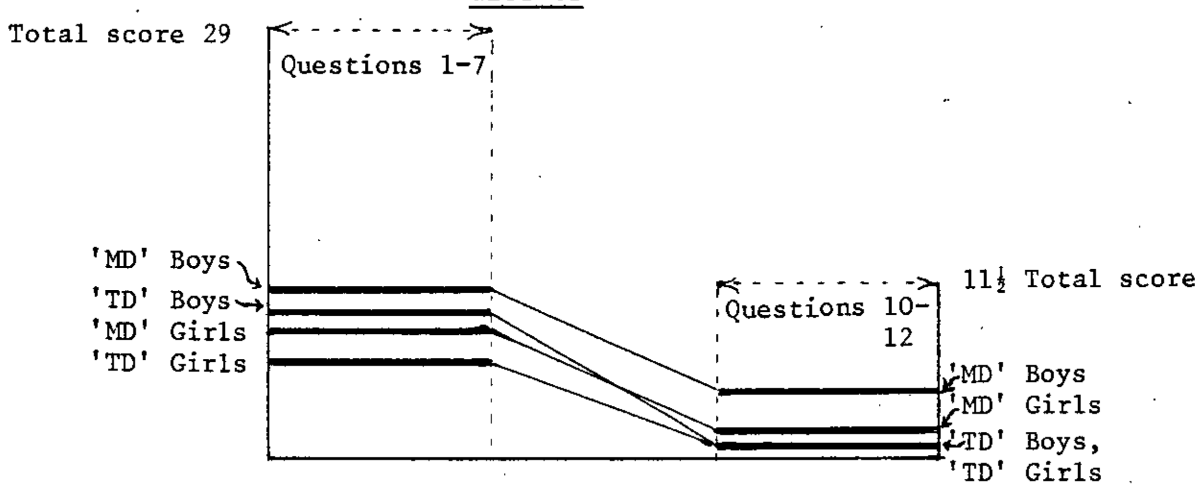
TEST I



In Test II, the pupils are ordered according to scores in the first seven questions as follows: 'MD' boys, 'TD' boys, 'MD' girls and 'TD' girls. In the last three questions, the 'MD' boys come at the top followed by the 'MD' girls, and the 'TD' boys and the 'TD' girls share the third place. So the dispersion of the pupils according to the result in Test II can be shown by Diagram 2.2.

Diagram 2.2

TEST II



It is clear from Diagram 2.2 that in the first seven questions of Test II, difference in programme kept the 'MD' boys separate from the 'TD' boys and the 'MD' girls separate from the 'TD' girls in favour of the modern programme. But the difference in sex is greater than the difference in programme, that is, the modern programme could not compensate for the handicap of being a girl. However, in the last three questions, being in the modern programme compensates for the handicap of being a girl and leaves an advantage.

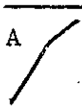
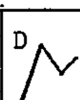
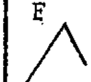
In summary, Diagrams 2.1 and 2.2 show that the advantage of being in the modern programme is greater than the advantage of being a boy.

Figures 2.5 and 2.6 show the weaknesses of the four types of pupil in each item of the tests. They show the relationship between the mean scores of the pupils in a particular test and their facility values. The graphs in Figures 2.5 and 2.6 can be summarised in seven categories: A, B, C, D, E, F, and G as shown in Table 2.5 (a and b). Other than category G, the shape of each category is the same in Table 2.5 (a) and Table 2.5 (b). A shape for category G could not be drawn because the graphs for which this category stands are quite different.

For Test I (see Table 2.5 (a)), the order of pupils according to test mean scores arranged in descending order is as follows:

'MD' boys, 'TD' boys, 'MD' girls and 'TD' girls (see Figure 2.5).

Table 2.5 (a)

Categories	A 	B 	C 	D 	E 	F 	G
Items of Test I	8,10,16, 22,30	15,20, 23,31, 32	3, 5	4,6,7, 11,13, 21	14,17,9 18,24, 27,28,29	19,25, 26	1,2,12

Type A graph indicates that the result of the pupils in these items is consistent with their mean scores in the test. The sex difference appears to be greater than the programme difference. The 'TD' boys performed better than the 'MD' girls in these particular items. But still the modern programme remains better than the traditional programme since the 'MD' boys performed better than the 'TD' boys and the 'MD' girls performed better than the 'TD' girls.

Type B shows that the programme difference, which is in favour of the modern programme, is greater than the sex difference. The graph shows that the 'MD' girls performed better than the 'TD' boys.

Type C shows that the results of the pupils in these items are independent, that is, sex and programme differences are not shown by the graph.

Type D, like type B, indicates that the programme difference is greater than the sex difference. The 'MD' girls performed better than the 'TD' boys. But also the 'MD' girls performed better than the 'MD' boys which was not expected. Nevertheless, the 'MD' boys performed better than the 'TD' boys.

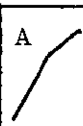
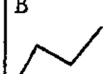
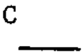
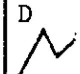
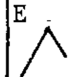
Type E shows that the 'TD' boys performed better than the 'MD' girls. This indicates that the sex difference appears to be greater than the programme difference.

Type F indicates that the 'MD' boys performed less well than expected. However, the 'MD' girls performed better than the 'TD' boys. This indicates that the programme difference is greater than the sex difference in favour of the modern programme.

For type G, the results of the pupils are not sufficiently consistent for a representative shape for the graphs of items 1, 2 and 12 to be drawn. So these items can be classified as exceptional (see Appendix G).

For Test II (see Table 2.5 (b)), the order of pupils according to test mean scores is as follows: 'MD' boys, 'MD' girls, 'TD' boys and 'TD' girls (see Figure 2.5).

Table 2.5 (b)

Categories	A 	B 	C 	D 	E 	F 	G
Items of Test II	5,10,11	2,3	8	6,7,12	1,9	none	4

Type A graph indicates that the results of these items are consistent with the test mean scores. Thus, the modern programme remains better than the traditional one. Also, unlike the situation in Test I, the programme difference is greater than the sex difference in favour of the modern programme. The 'MD' girls performed better than the 'TD' boys.

Type B shows that the sex difference is greater than the programme difference. The 'TD' boys performed better than the 'MD' girls. This is contrary to the situation in Test I. But the 'MD' boys performed better than the 'TD' boys, and the 'MD' girls performed better than the 'TD' girls which indicates that the modern programme is better than the traditional one.

As shown in Test I, Type C shows that neither programme nor sex makes any difference.

Type D shows results contrary to those in Test I. Here the sex difference is greater than the programme difference. The 'TD' boys performed better than the 'MD' girls. Although the 'MD' girls performed better than the 'TD' girls, the 'TD' boys performed better than the 'MD' boys. This suggests, also, that the modern and traditional programmes are almost the same.

Type E shows results contrary to those it shows in Test I. The 'MD' girls performed best of all. In particular, the 'MD' girls performed better than the 'TD' boys which indicates that the modern programme makes greater difference than the sex does. It is, also, clear that the modern programme is better than the traditional one.

For Type G, the results of the 'MD' girls and the 'TD' boys are similar (see result of question 4 in Appendix H). So the programme and sex differences are almost equal. On the other hand, no difference between programmes is shown. The 'MD' boys performed better than the 'TD' boys, but the 'TD' girls performed better than the 'MD' girls (see Appendix H). Also, the 'TD' girls performed better than the 'MD' girls and the 'TD' boys. This feature classifies this item as exceptional.

Although the 'TD' boys lead the 'MD' boys in several items in Test I, the overall picture shown by Table 2.5 shows results which are consistent with the results obtained from Diagrams 2.1 and 2.2. Furthermore, on the basis of the graphical item analysis conducted above and the results of the 'modern' pupils shown in Appendices G and H, the teaching of basic skills, especially those involved in verbal problems, needs to be reinforced. The low scores of all pupils in items 6, 7 and 9 of Test II (see Appendix H) may indicate that the topics tested by those items are too advanced for inclusion in the syllabus. These items were set in the same format as used in the textbooks.

The response to the attitude scale of 1982 was disappointing. There were 1024 papers which can be classified as follows: A set of papers having contradictory responses to similar items (Set A), a set of papers having total attitude scores inconsistent with corresponding test scores (Set B) and a set of papers having total attitude scores consistent with corresponding test scores (Set C). Note that:

$$A \cap B = \emptyset, \quad A \cap C = \emptyset .$$

There were eight items in this scale (see Appendix A). In each item, the response which was most in favour of mathematics received 5 marks, the next received 4, 3, 2 and 1 respectively. So the maximum score of the scale was 40, the minimum score was 8, with a 'passing score' of 24. Those scales which showed conflicting responses on any similar item pair were rejected as unreliable (Set A). Of the rest, those with attitude scores of 24 or greater and average achievement scores of less than 25 (the passing test score), and those with attitude scores less than 24 and average achievement scores of 25 or greater (Set B), were removed in order to leave an unambiguously valid set of responses for further analysis. So the responses in Set C were analysed. The proportions of pupils in Set C are given in Table 2.6.

Table 2.6

Pupils	'TD' Boys	'MD' Boys	'TD' Girls	'MD' Girls
Proportion	0.24	0.32	0.21	0.24

The number of valid responses is 259 which is about 1/4 of the total number of responses. The proportions of pupils who gave positive responses to the different items are shown in Table 2.7.

Table 2.7

Item	A	B	C	D	E	F	G	H
'TD' Boys	0.77	0.77	0.80	0.80	0.72	0.69	0.77	0.87
'MD' Boys	0.81	0.83	0.85	0.85	0.79	0.88	0.92	0.69
'TD' Girls	0.51	0.51	0.49	0.51	0.43	0.55	0.62	0.66
'MD' Girls	0.67	0.67	0.72	0.72	0.52	0.67	0.67	0.67

From Table 2.7, it is clear that in each item, the 'MD' boys have a better attitude towards mathematics than the 'TD' boys have, except in item H. Also, the 'MD' girls have a better attitude towards mathematics than the 'TD' girls in all items. Perhaps item H is not a good measure because pupils in the elementary schools do not apply mathematics in other subjects except in a very narrow way.

In all, the scale shows better attitude towards the modern programme.

2.1.6 A Comparison of the Results Obtained by the Pupils of 1982 and the Pupils of 1983 in Tests I and II

In this comparison there are eight types of pupil grouped in pairs, thus forming four groups (see Appendices J and K). Each group pair belongs to the same schools, one constituent of the pair being the '1982' pupils and the other being the '1983' pupils. Then each pair is compared.

Figures 2.7 to 2.14 show the distributions of scores obtained by the different groups of pupils in Tests I and II. The results are summarised in Table 2.8.

Table 2.8(a)

Result of Test I

Group	Type of pupil	Proportion of pupils scoring < 25	Proportion of pupils scoring ≥ 25
1	'TD' Boys of 1982	0.39	0.61
	'MD' Boys of 1983	0.31	0.69
2	'MD' Boys of 1982	0.29	0.71
	'MD' Boys of 1983	0.29	0.71
3	'TD' Girls of 1982	0.72	0.28
	'MD' Girls of 1983	0.40	0.60
4	'MD' Girls of 1982	0.34	0.66
	'MD' Girls of 1983	0.35	0.65

<u>Comments</u>

1. In group 1, about 1/5 of the boys who would 'fail' on the traditional programme in 1982 would 'pass' on the modern programme in 1983. Thus there is progress in boys' attainment.

2. In group 2, it seems that there is no change in boys' attainment from 1982 to 1983.
3. In group 3, about 2/5 of the girls who would 'fail' on the traditional programme in 1982 would 'pass' on the modern programme in 1983.
4. In group 4, it seems that there is no change in girls' attainment from 1982 to 1983.

Table 2.8(b)

Result of Test II

Group	Type of pupil	Proportion of pupils scoring < 25	Proportion of pupils scoring ≥ 25
1	'TD' Boys of 1982	0.75	0.25
	'MD' Boys of 1983	0.64	0.36
2	'MD' Boys of 1982	0.60	0.40
	'MD' Boys of 1983	0.61	0.39
3	'TD' Girls of 1982	0.87	0.13
	'MD' Girls of 1983	0.76	0.24
4	'MD' Girls of 1982	0.71	0.29
	'MD' Girls of 1983	0.68	0.32

Comments

1. In group 1, about 1/5 of the boys who would 'fail' on the traditional programme in 1982 would 'pass' on the modern programme in 1983. There is almost the same amount of progress in Test I.
2. In group 2, as in Test I, there seems to be no change from 1982 to 1983.
3. In group 3, about 1/8 of the girls who would 'fail' on the traditional programme in 1982 would 'pass' on the modern programme in 1983. There is progress in girls' attainment from 1982 to 1983.
4. In group 4, there seems to be no significant difference between the attainment of girls in 1982 and 1983.

Table 2.9(a)

Topics	Av. Score for Gr.1 in percentage		Av. Score for Gr.2 in percentage	
	'TD' Boys of 1982	'MD' Boys of 1983	'MD' Boys of 1982	'MD' Boys of 1983
Basic Definitions	71	67	67	67
Arithmetic Operations	52	60	52	63
Arithmetic Problems	39	32	28	36
Algebraic Thinking	17	32	33	34
Geometric Constructions	38	67	65	67

Table 2.9(b)

Topics	Av. Score for Gr.3 in percentage		Av. Score for Gr.4 in percentage	
	'TD' Girls of 1982	'MD' Girls of 1983	'MD' Girls of 1982	'MD' Girls of 1983
Basic Definitions	57	75	65	71
Arithmetic Operations	39	50	55	55
Arithmetic Problems	18	24	36	34
Algebraic Thinking	15	23	22	25
Geometric Constructions	13	55	51	62

Table 2.9 gives a clear picture for comparing pairs in all groups. The table does not show consistent results in mastering basic definitions and solving arithmetic problems. However, it shows improvement in all groups in algebraic thinking and in skill in geometric constructions. Also the table shows an improvement in tackling arithmetic operations. This is especially clear in the results of Groups 1 and 2. This improvement may be due to more revision time which was not available for the 'modern pupils' of 1982. The performance of the 'modern girls' of 1983 (see group 3) in arithmetic problems was lower than the performance of all other pupils of 1983.

The majority of pupils did not respond to the questions of the attitude scale. This may be due to the relative difficulty in following the instructions by the children alone without guidance of the teachers. The teachers were asked to guide their pupils to complete the scale (see Appendix B), but it seems that the teachers did not co-operate. Therefore, the scale was considered as invalid.

The present study has, therefore, indicated that information gained from attitude scales is very limited. For children, in particular, attitude scales are likely to give unreliable results even if they attempt the questions (see the discussion of the result of the scale administered in 1982). These findings are consistent with previous findings of other studies and with claims about attitude scales. Uncertainty that a respondent states his true attitude is a disadvantage of attitude scales (Borg and Gall, 1979).

2.2 CONCLUSION

From the foregoing discussion, it seems that the modern programme has contributed to a better learning of mathematics in Sudan. This statement is supported by the results of the tests administered in 1982, and confirmed by the results of the tests in 1983. The following paragraphs of this section are devoted to answering those particular questions posed in Chapter One and which this study has sought to answer.

1. Could the modern programme give greater help to the lower achievers? Test I was intended to measure changes at low performance. The results of Test I (see Figures 2.1 and 2.3) clearly show that the modern programme is more suitable for weaker pupils.

2. Could the modern programme inspire the higher achievers to attain better in mathematics than the traditional programme could?

   Test II was intended to measure changes at high performance. Figure 2.2 shows that the modern programme offers opportunity so that the number of high scoring boys can be increased to the extent shown by the figure. Figure 2.4 shows that high scoring girls can only be found among those following the modern programme.

3. Could the modern programme give the pupils a better attitude towards mathematics?

   The answer to this question can only be sought in the result of the attitude scale administered in 1982. But only approximately a quarter of the pupils displayed reliable answers. However, among these the 'MD' pupils had reflected better attitude towards mathematics.

4. Did the pupils following both programmes master computational skills equally well?

   Table 2.2 shows that the 'MD' and 'TD' boys performed equally in the arithmetic operations, whereas there seems to be some difference between them in solving arithmetic problems in favour of the 'TD' boys.

   In the case of girls, Table 2.2 shows clearly that the 'MD' girls mastered computational skills much better than the 'TD' girls.

5. Which programme contributed better to algebraic thinking?

   Row four of Table 2.2 indicates that the 'MD' pupils tackled problems demanding algebraic thinking more competently than the 'TD' pupils. It can also be noted that, in addition to the overall better performance of the 'MD' pupils in Test II, they performed particularly relatively well in two concepts known to be poorly understood by the 'TD' pupils. These concepts are 'inverse proportion' and 'increase and decrease percent' (see Appendix H: questions 4 and 5 for 'inverse proportion' and questions 8, 10 and 11 for 'increase and decrease percent'). The 'TD' pupils were taught to tackle problems involving those concepts by intuition alone, which needs a high ability level. On the other hand, rules were derived for the 'MD' pupils to be applied in tackling those problems algebraically.

Finally, the overall picture shows that the modern programme could provide better opportunities for learning mathematics. Especially, it could contribute substantially to girls' mathematical understanding. This is shown in Diagrams 2.1 and 2.2. A possible interpretation for this phenomenon lies in the nature of girls and the nature of each programme. Traditionally, girls were condemned, socially, to be bad at mathematics. Feeling too shy to ask questions in the class-rooms, girls tend to learn alone. But owing to poor illustrations of methods and concepts in the traditional programme which encouraged pupils to learn by rote, the 'TD' girls did not have the opportunity to learn mathematics adequately. On the other hand, the modern programme, which emphasises understanding, gives clear illustrations for methods and concepts. So the 'MD' girls have an opportunity to learn mathematics by themselves in addition to what they can appreciate in the classroom.

2.3 LIMITATIONS OF THE STUDY

The findings of quasi-experimental studies are limited. Furthermore, the findings of this study are limited because the 'MD' and 'TD' pupils did not spend equal times on doing extra exercises. Nevertheless, the overall results showed that the modern programme is an improvement on the traditional one.

FIGURE 2.1

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT
OF MODERN & TRADITIONAL BOYS IN TEST I

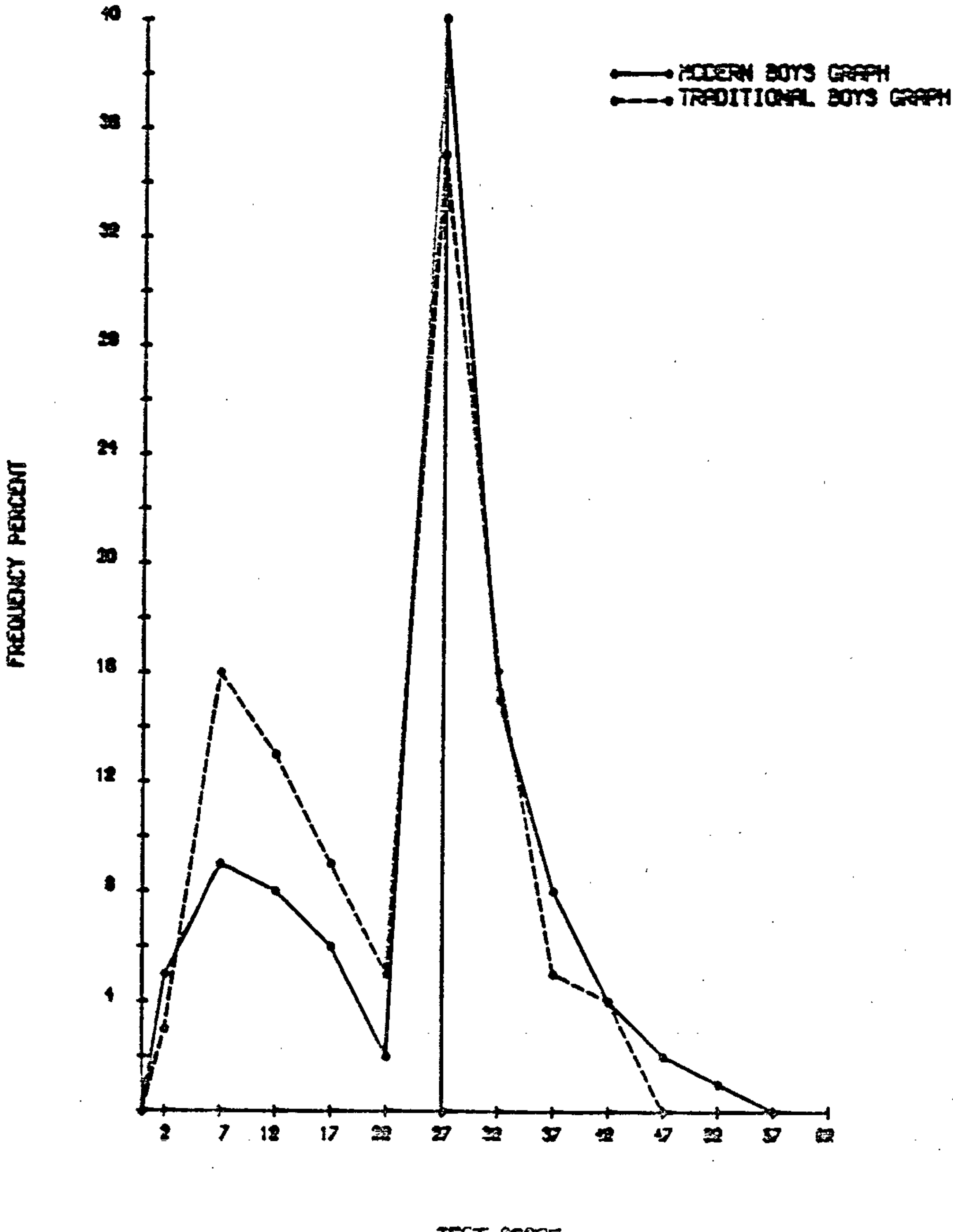


FIGURE 2.2

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF MODERN & TRADITIONAL BOYS IN TEST II

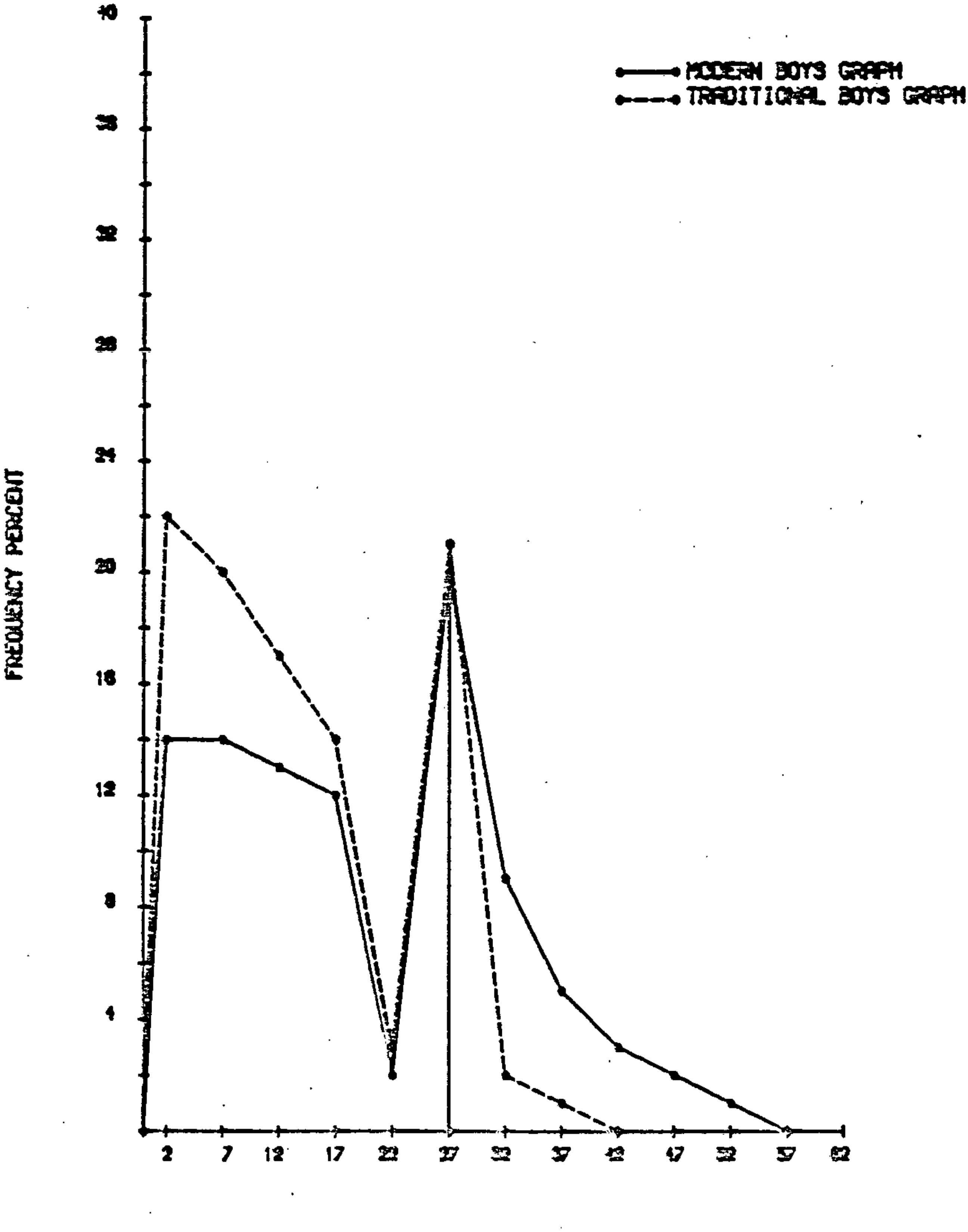


FIGURE 2.3

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF MODERN & TRADITIONAL GIRLS IN TEST I

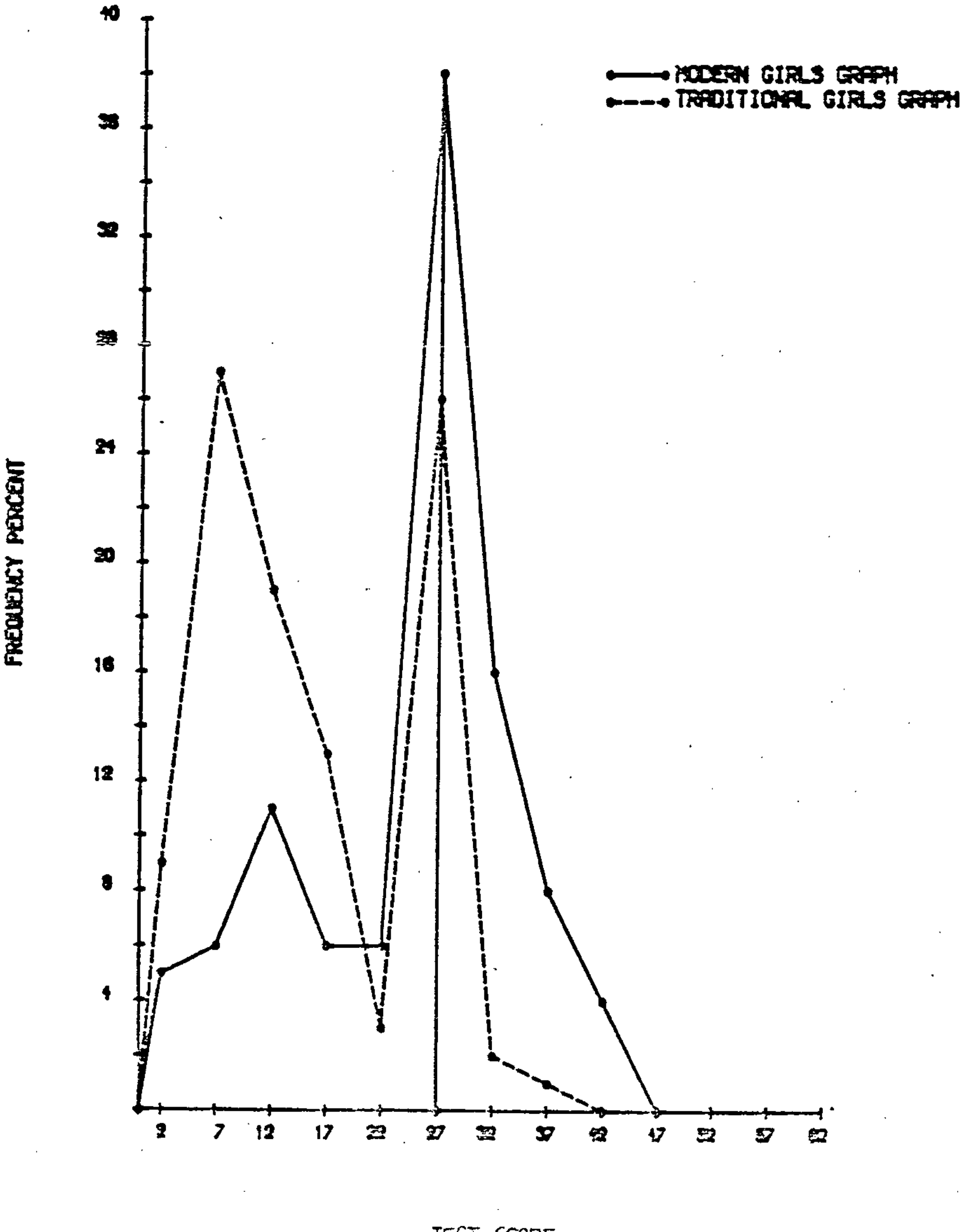


FIGURE 2.4

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF MODERN & TRADITIONAL GIRLS IN TEST II

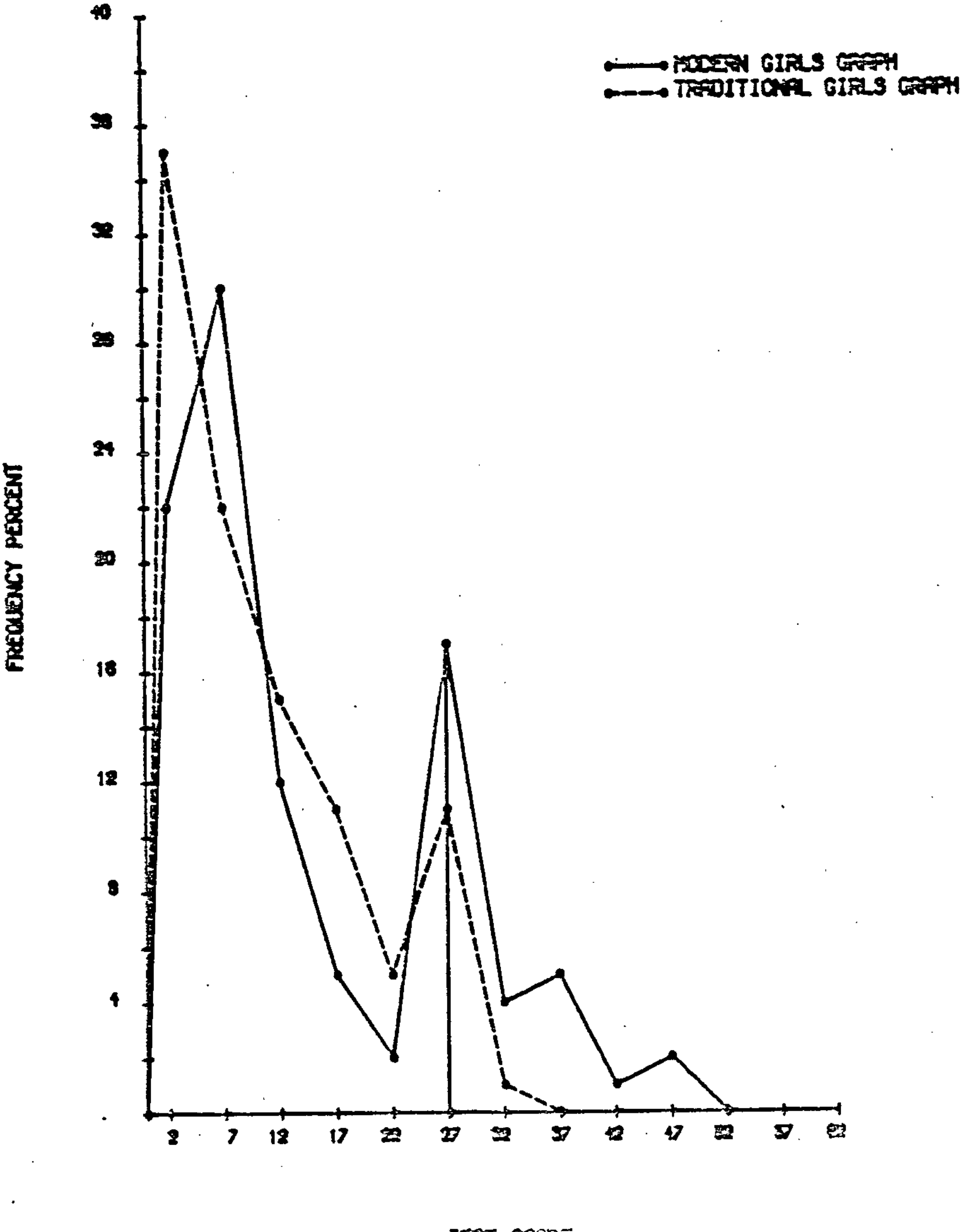


FIGURE 2.5 - MEAN SCORE PERCENT IN TEST I VERSUS FACILITY VALUE

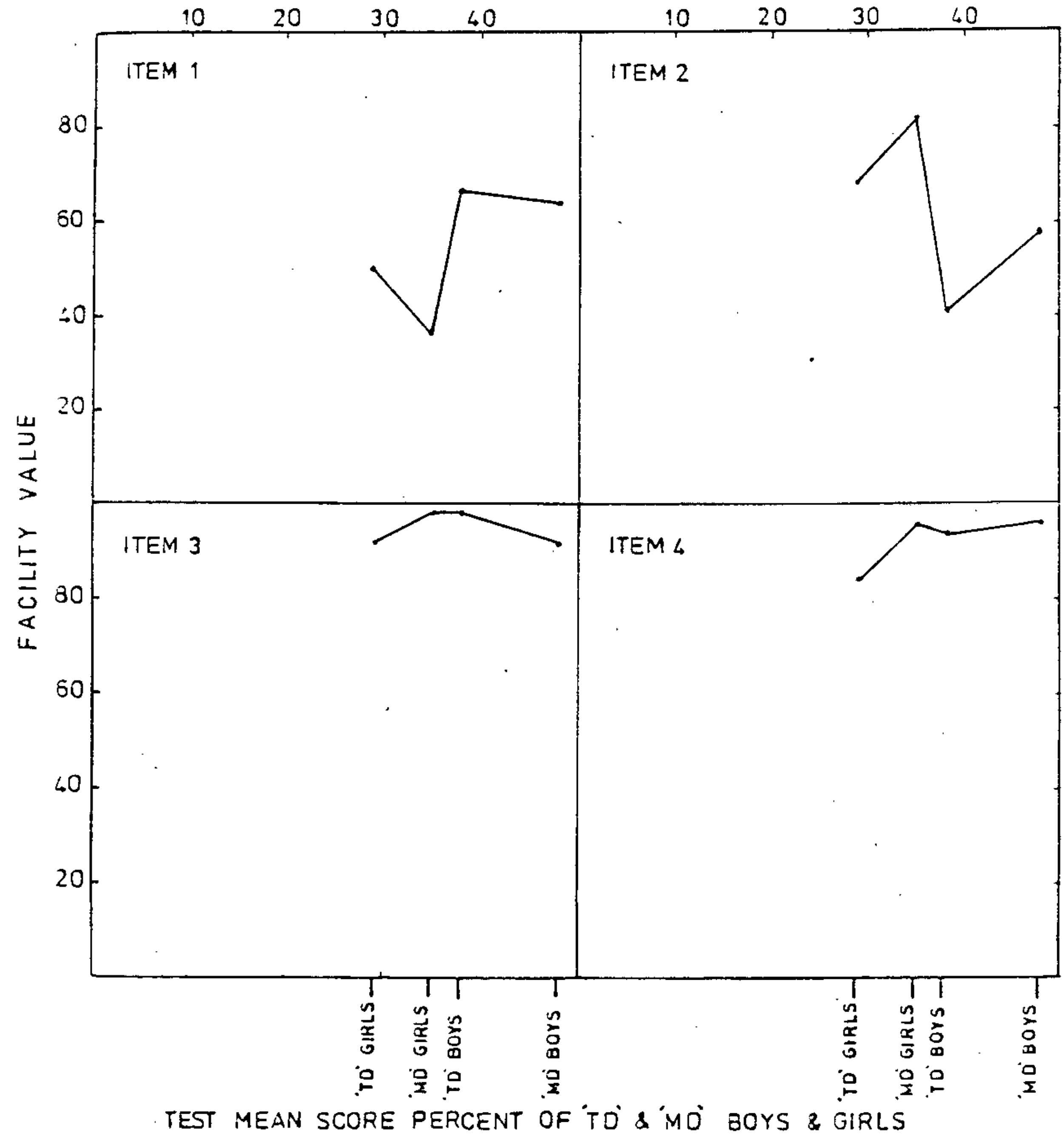


FIGURE 2 5 - CONTINUED

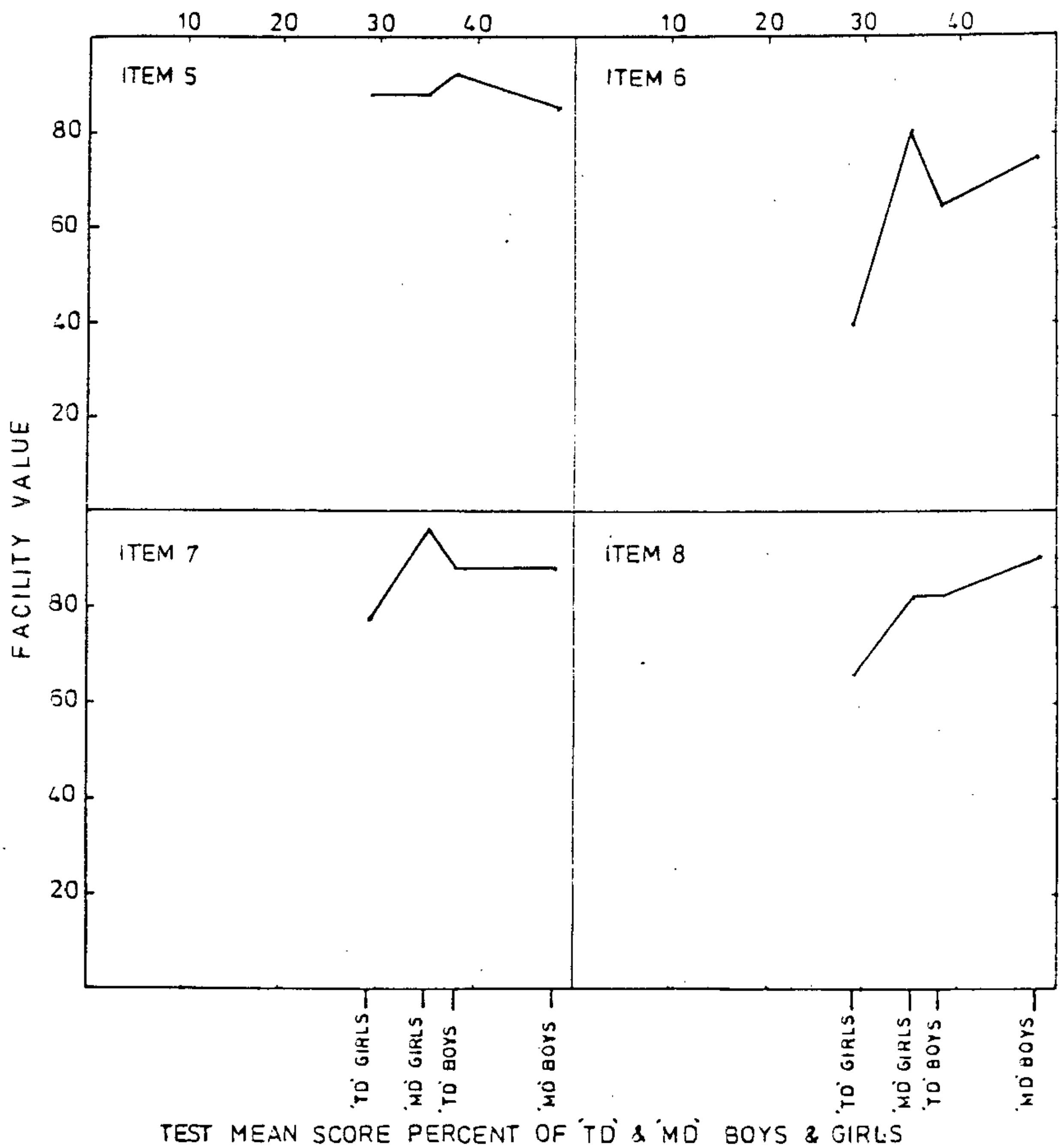


FIGURE 2.5 - CONTINUED

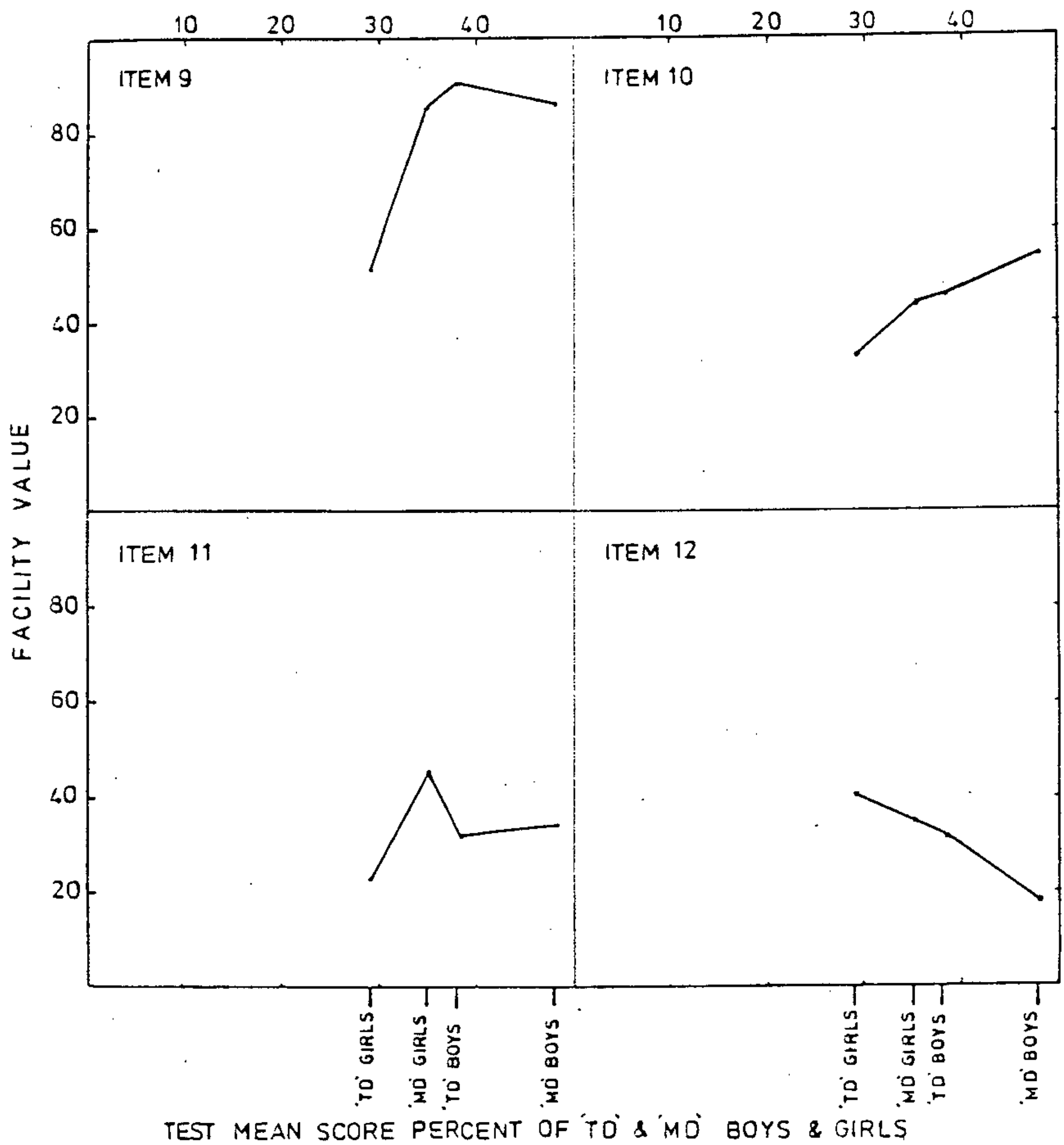


FIGURE 2.5 - CONTINUED

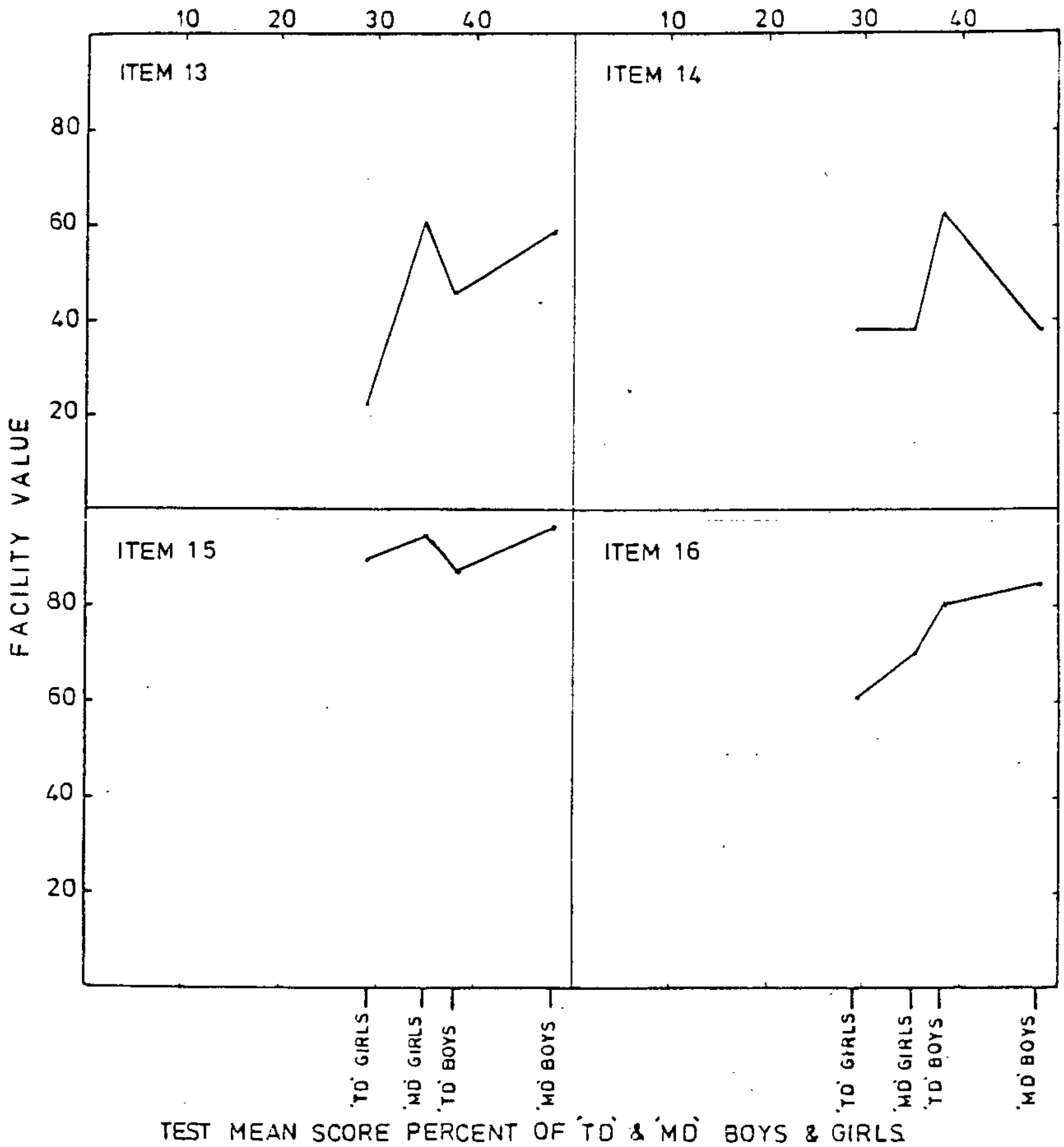


FIGURE 2.5 - CONTINUED

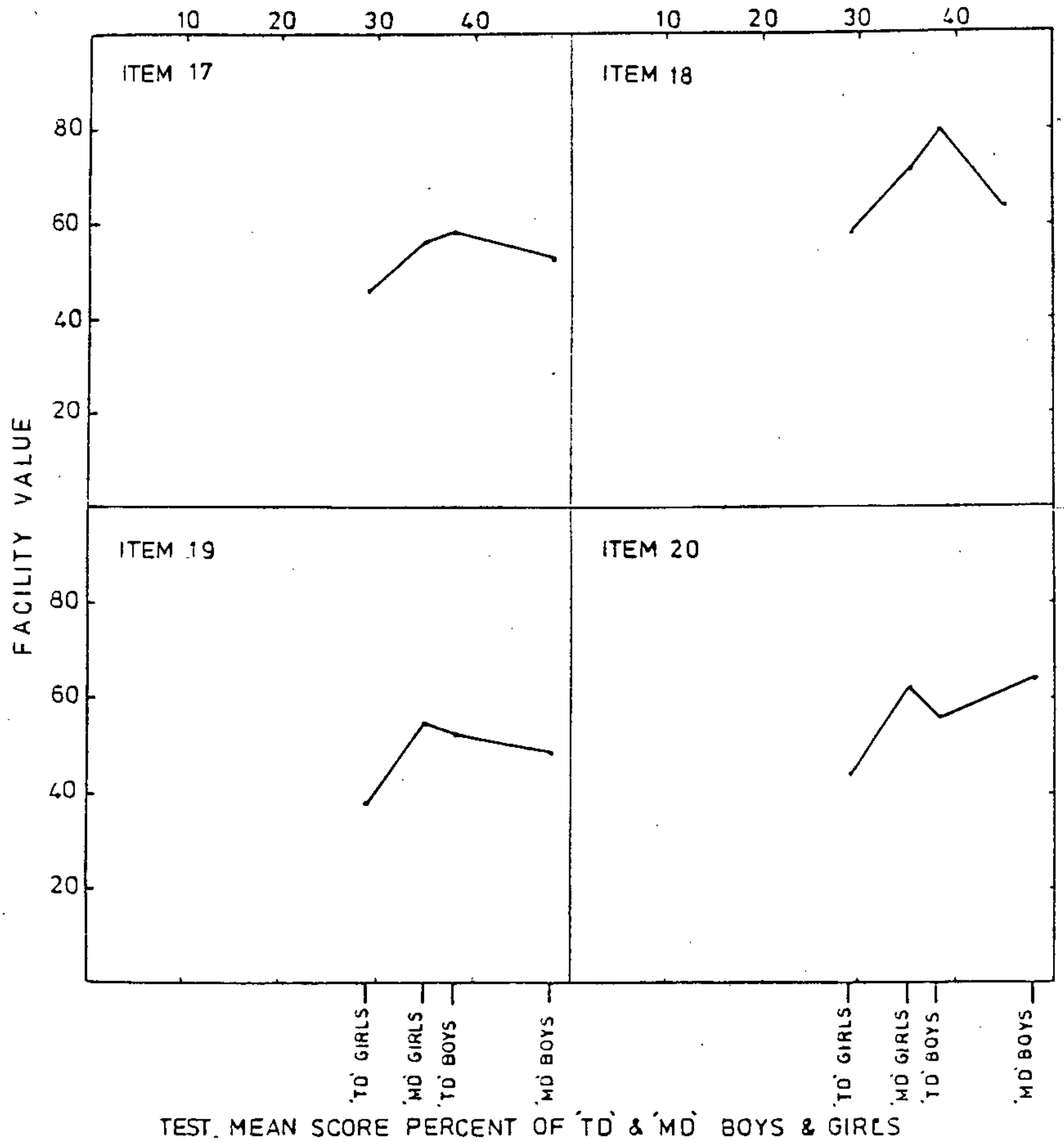


FIGURE 2.5 - CONTINUED

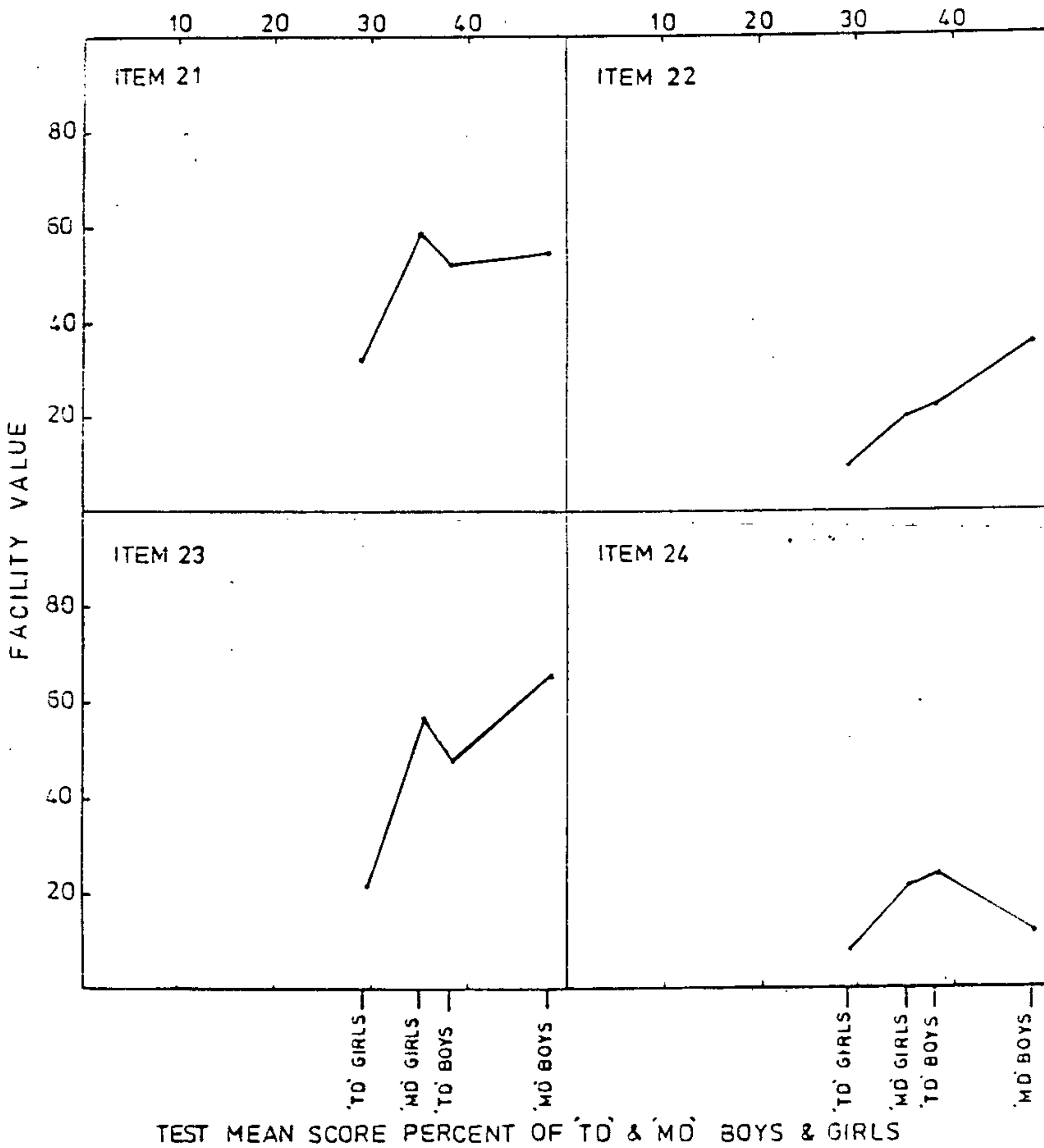


FIGURE 2.5 - CONTINUED

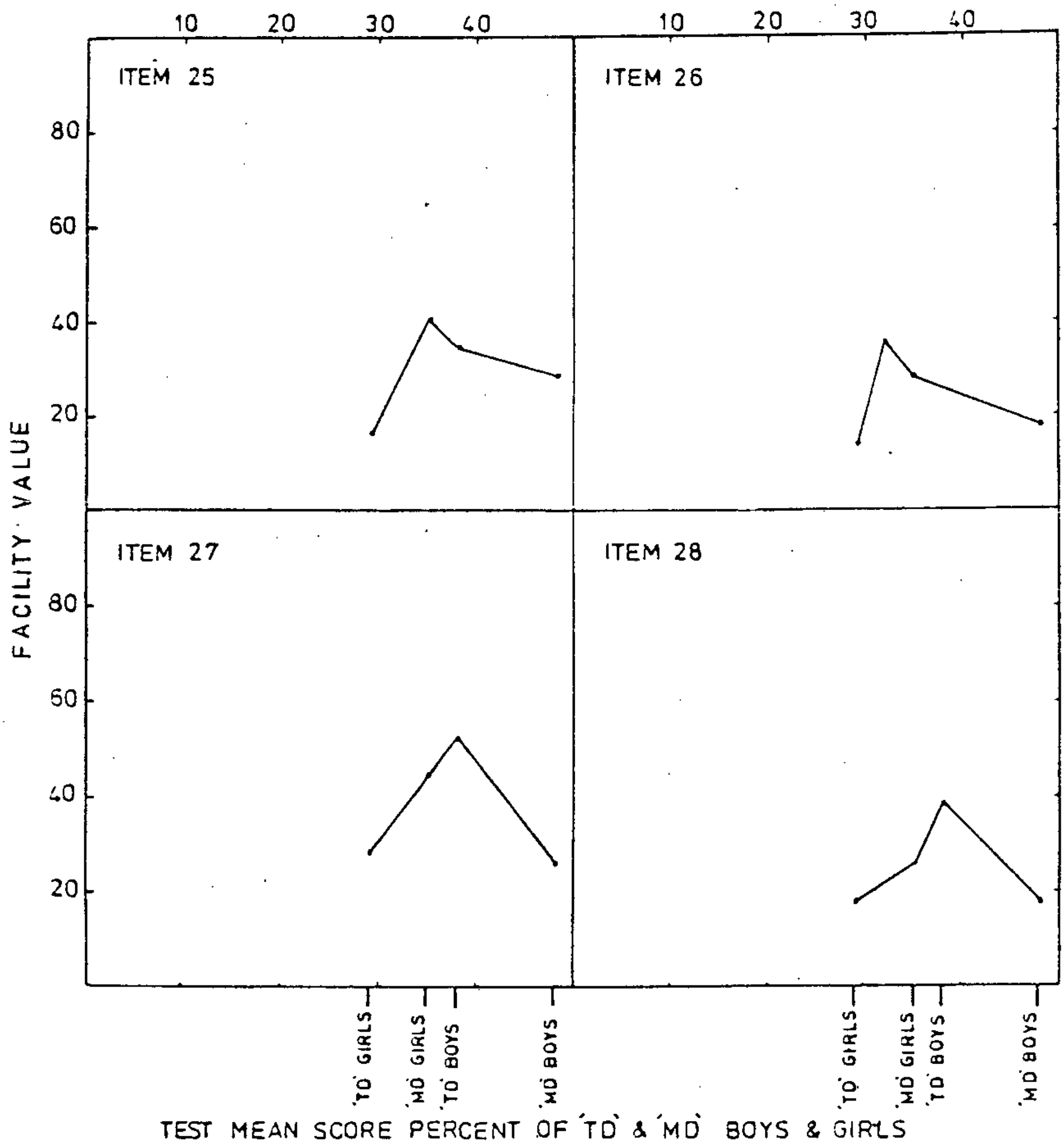


FIGURE 2.5 - CONTINUED

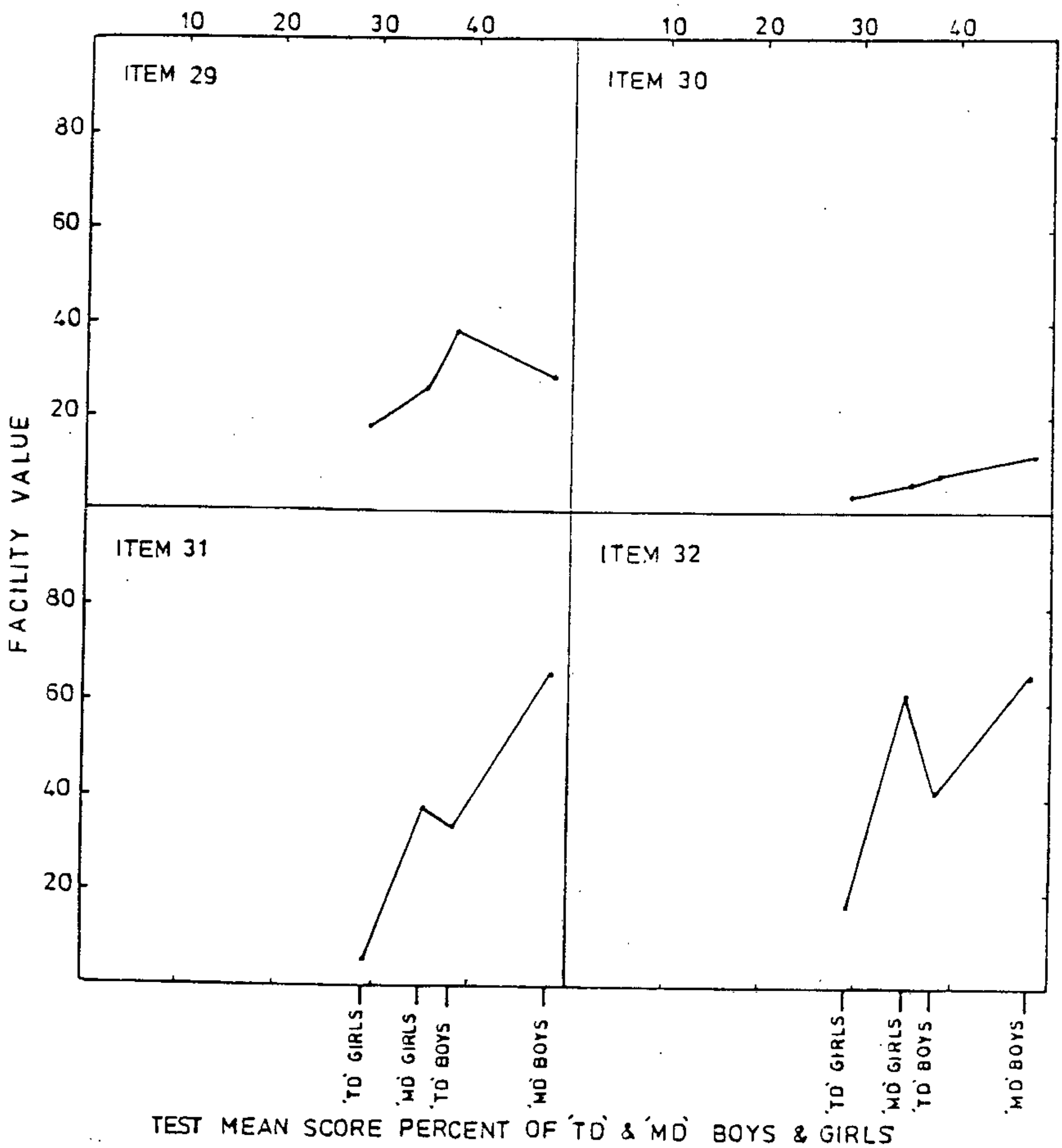


FIGURE 2.6 - MEAN SCORE PERCENT IN TEST II VERSUS FACILITY VALUE.

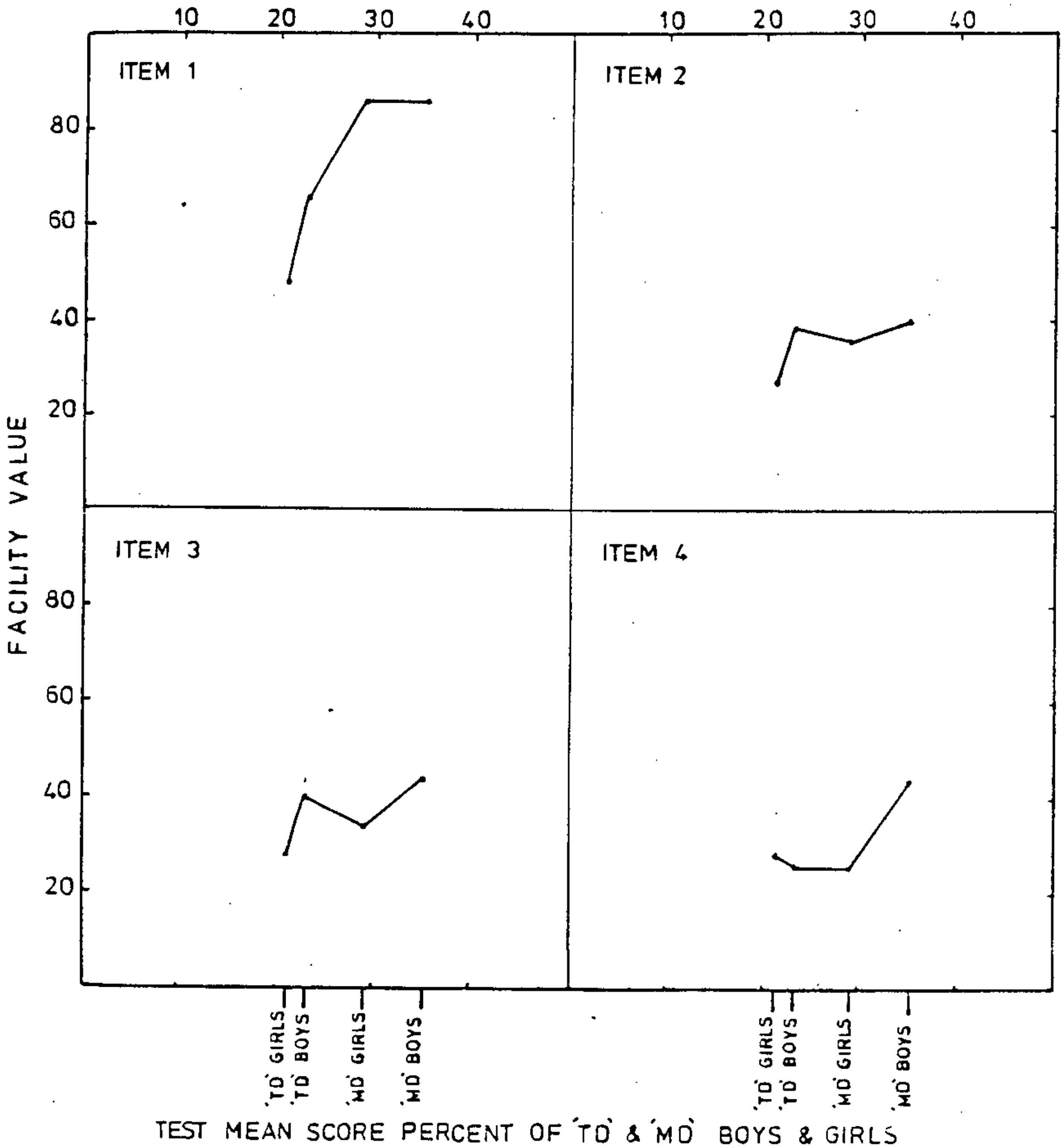


FIGURE 2.6 - CONTINUED

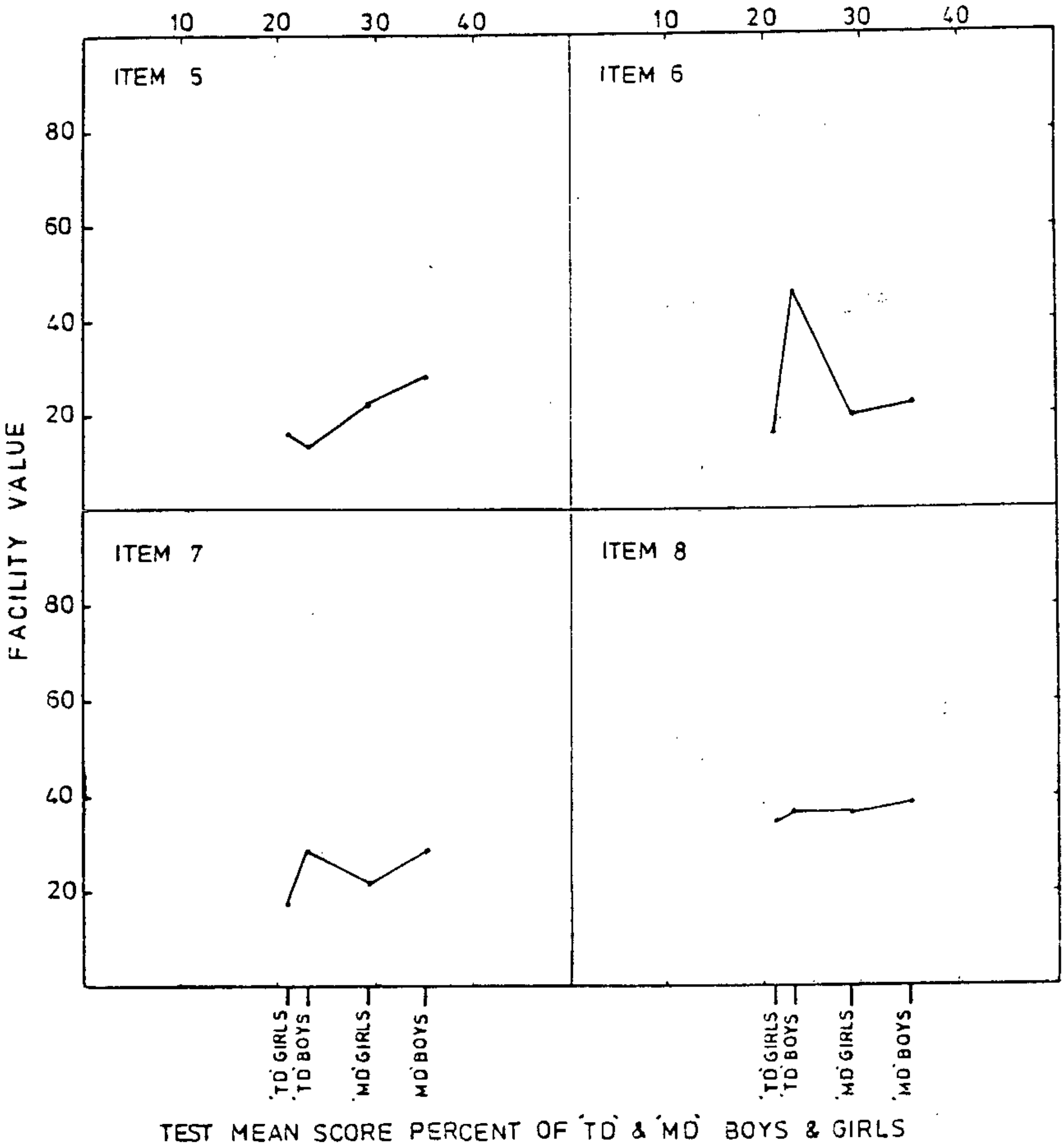


FIGURE 2.6 - CONTINUED

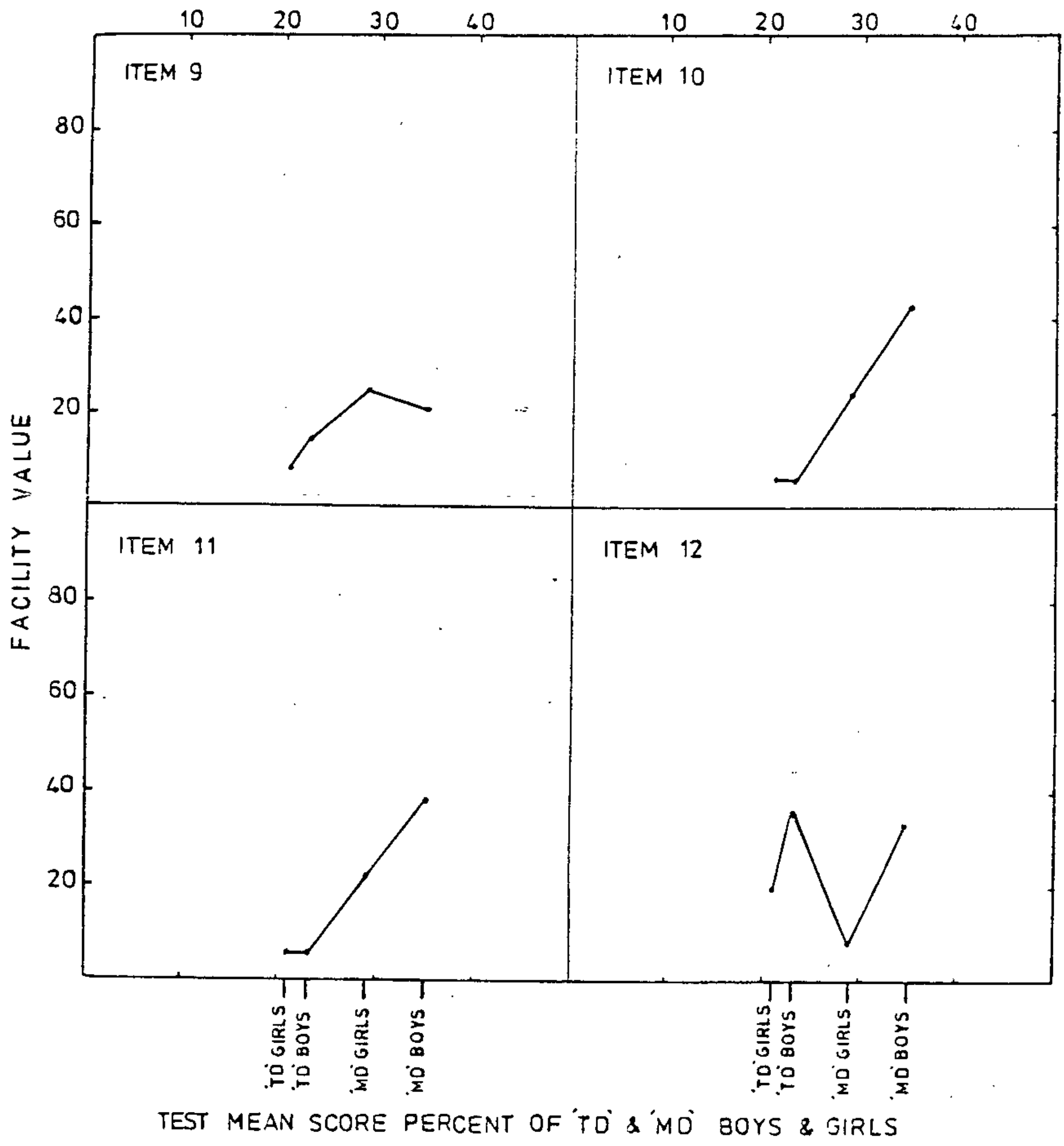


FIGURE 2.7

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 1' IN TEST I

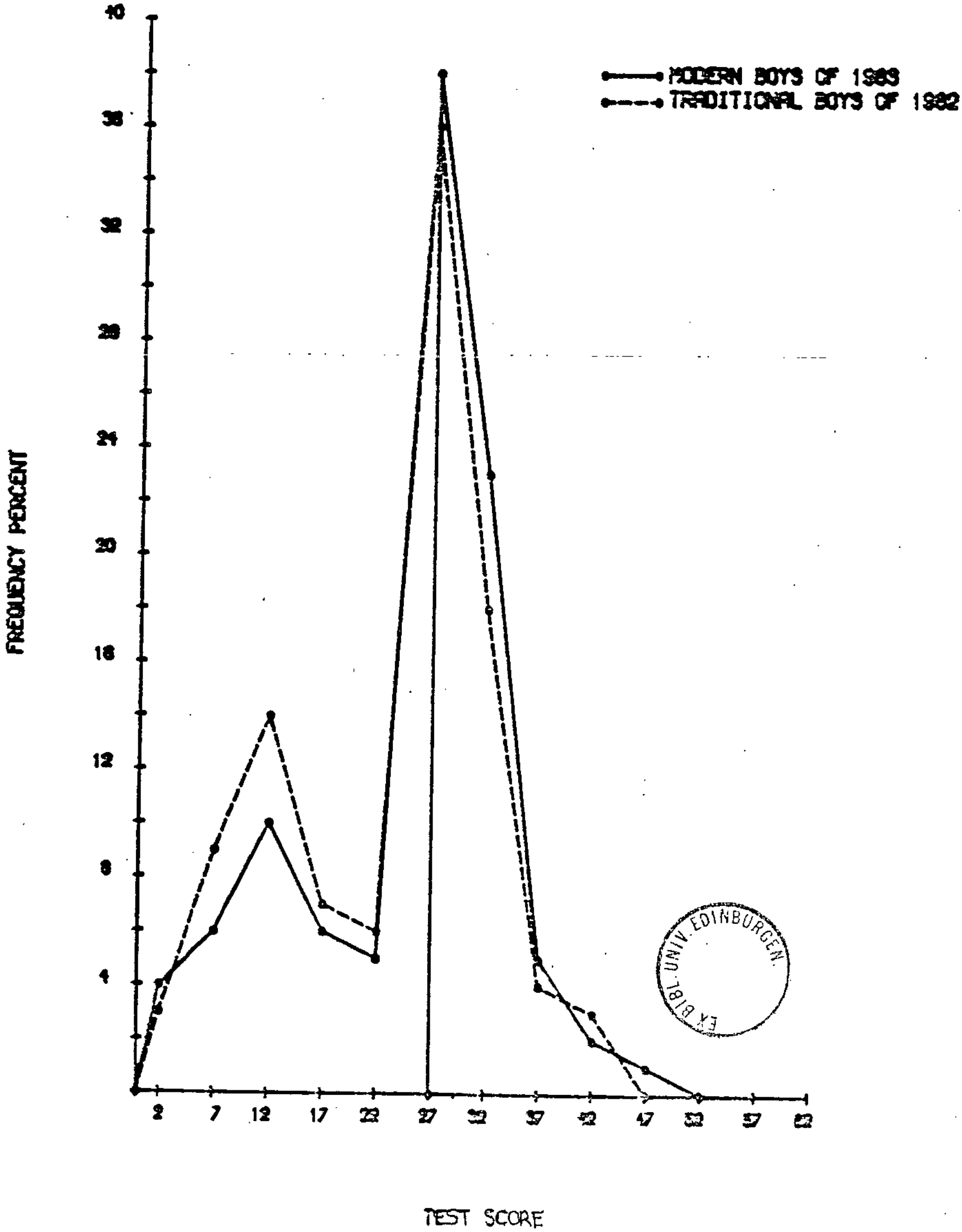


FIGURE 2.8

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 2' IN TEST I

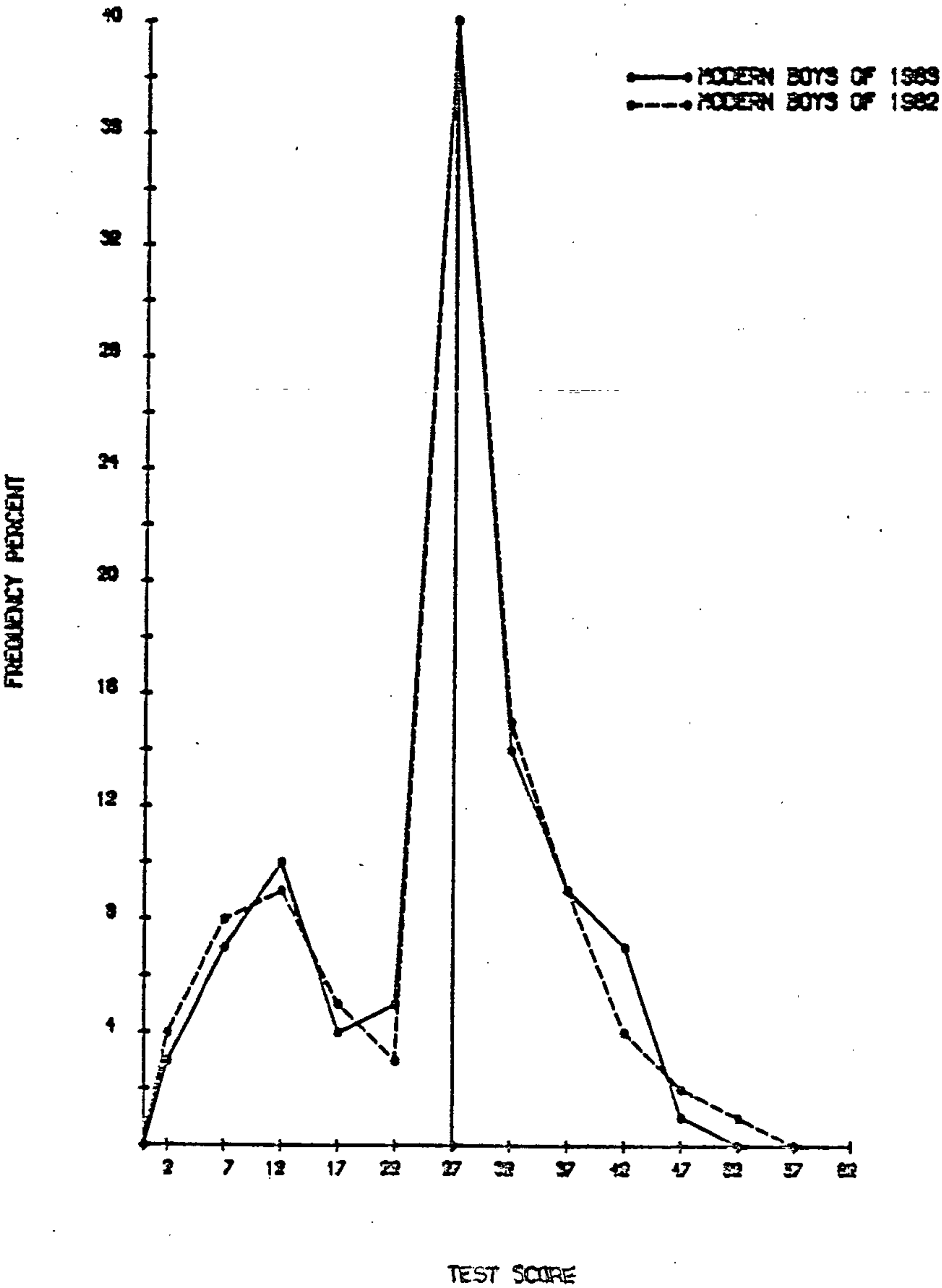


FIGURE 2.9

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 3' IN TEST I

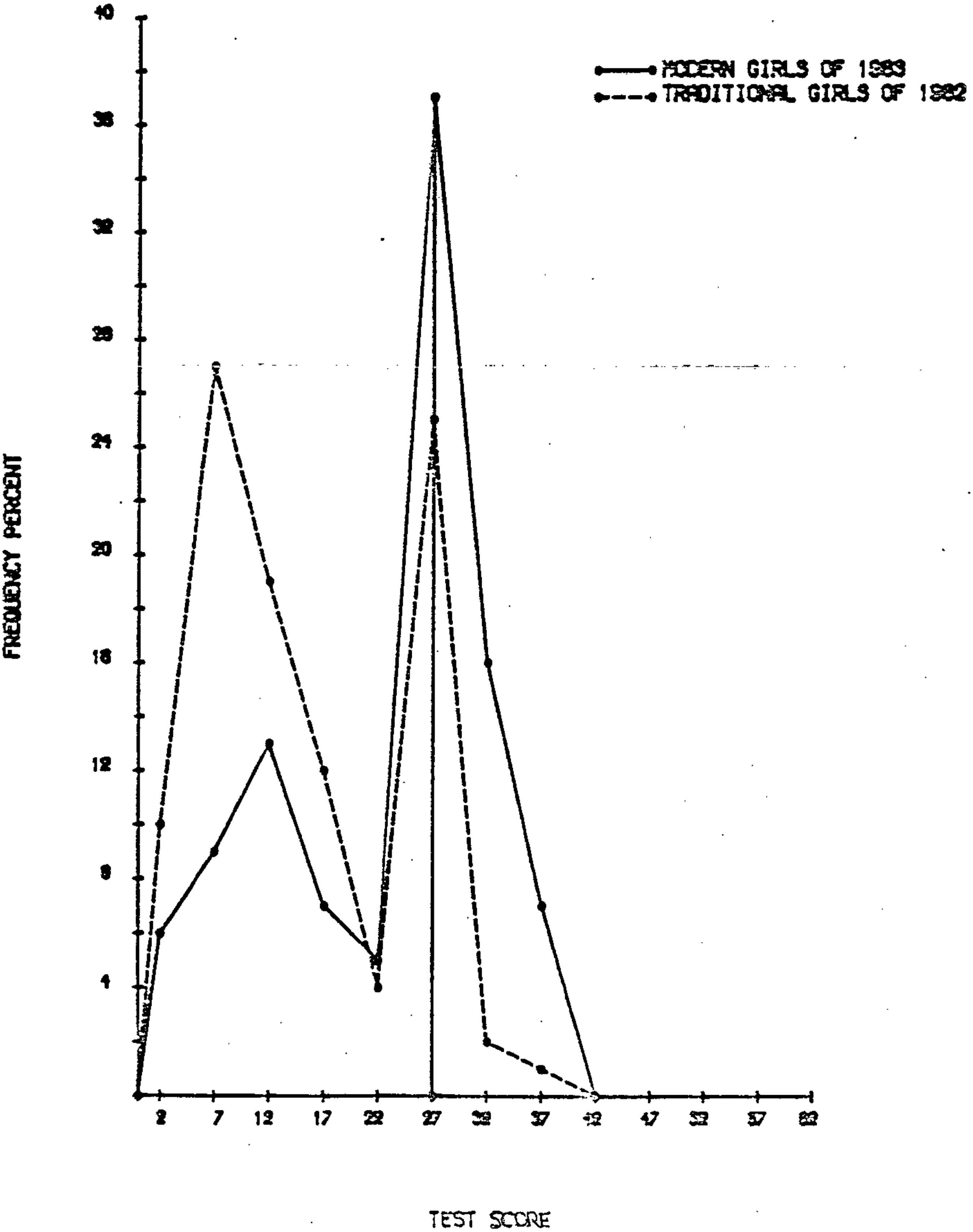


FIGURE 2.10

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 4' IN TEST I

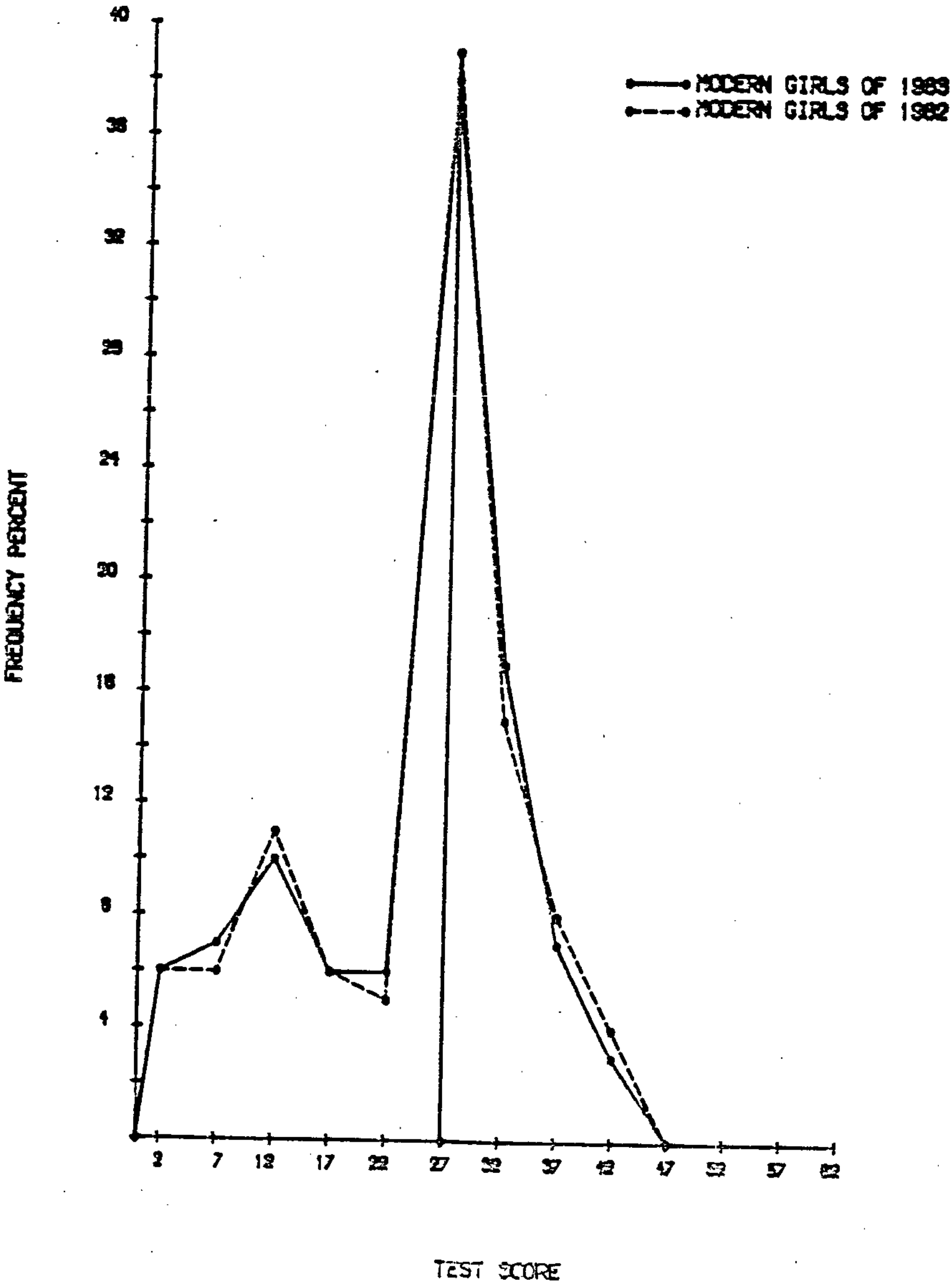


FIGURE 2.11

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 1' IN TEST II

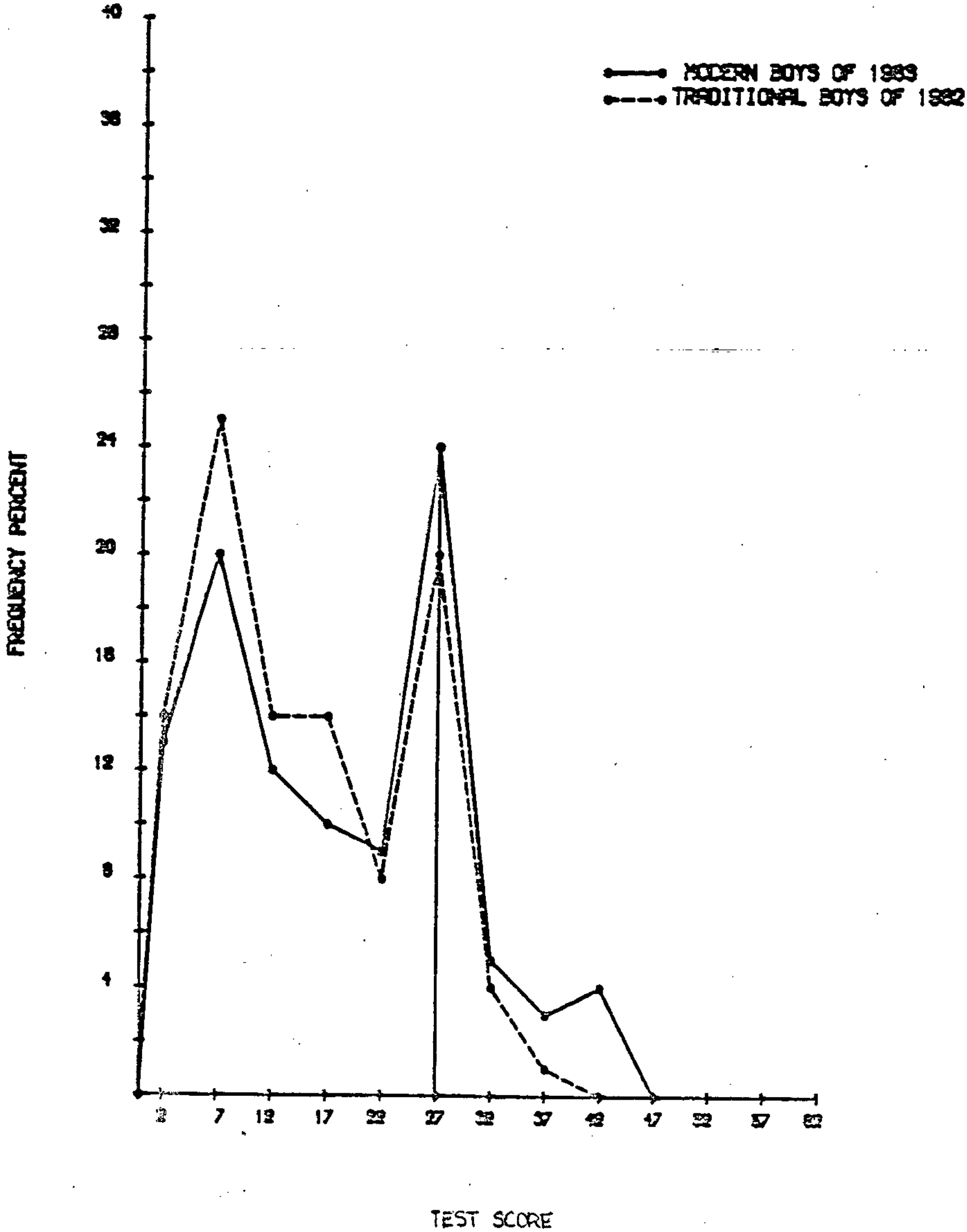


FIGURE 2.12

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 2' IN TEST II

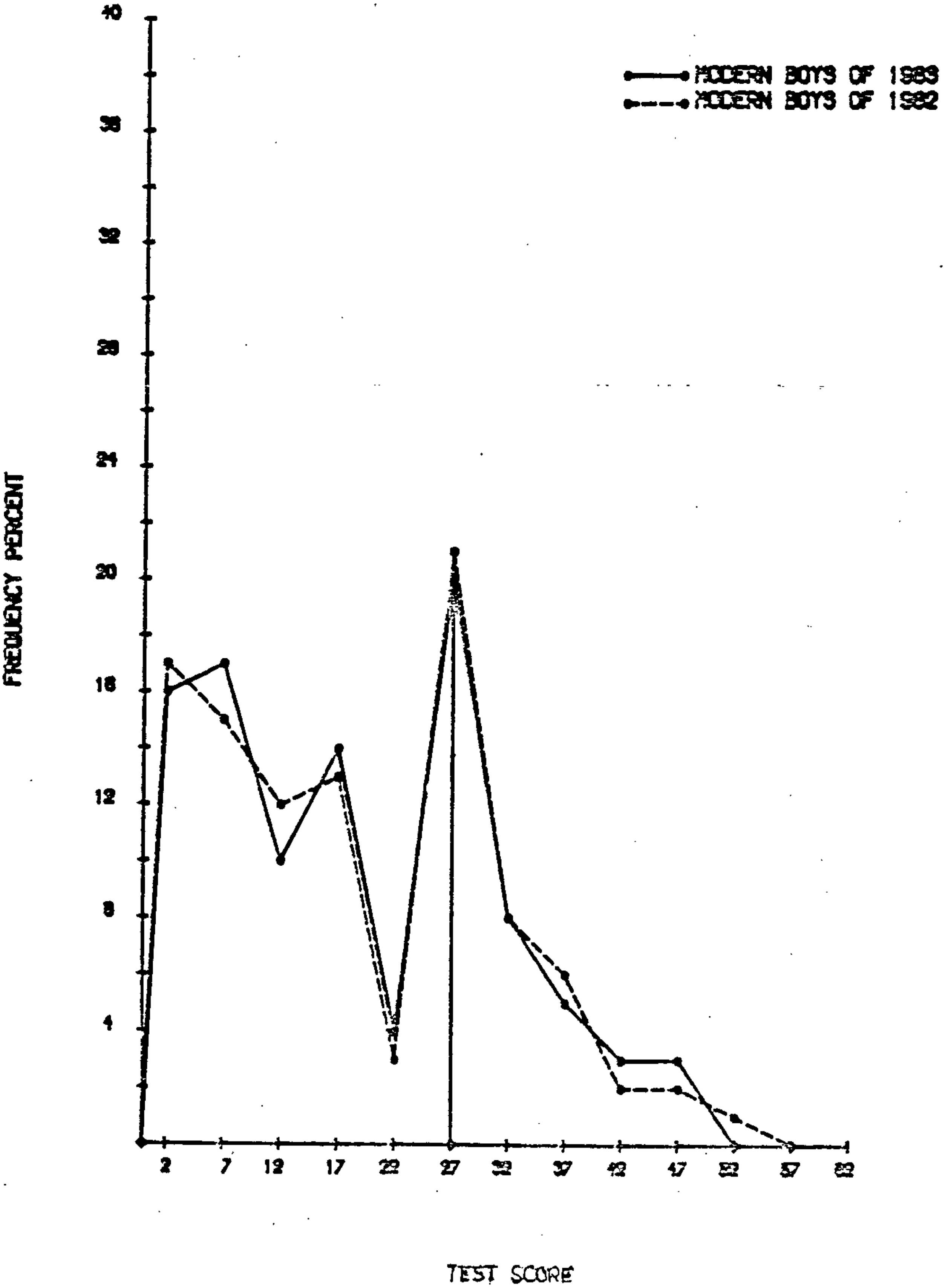


FIGURE 2.13

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 3' IN TEST II

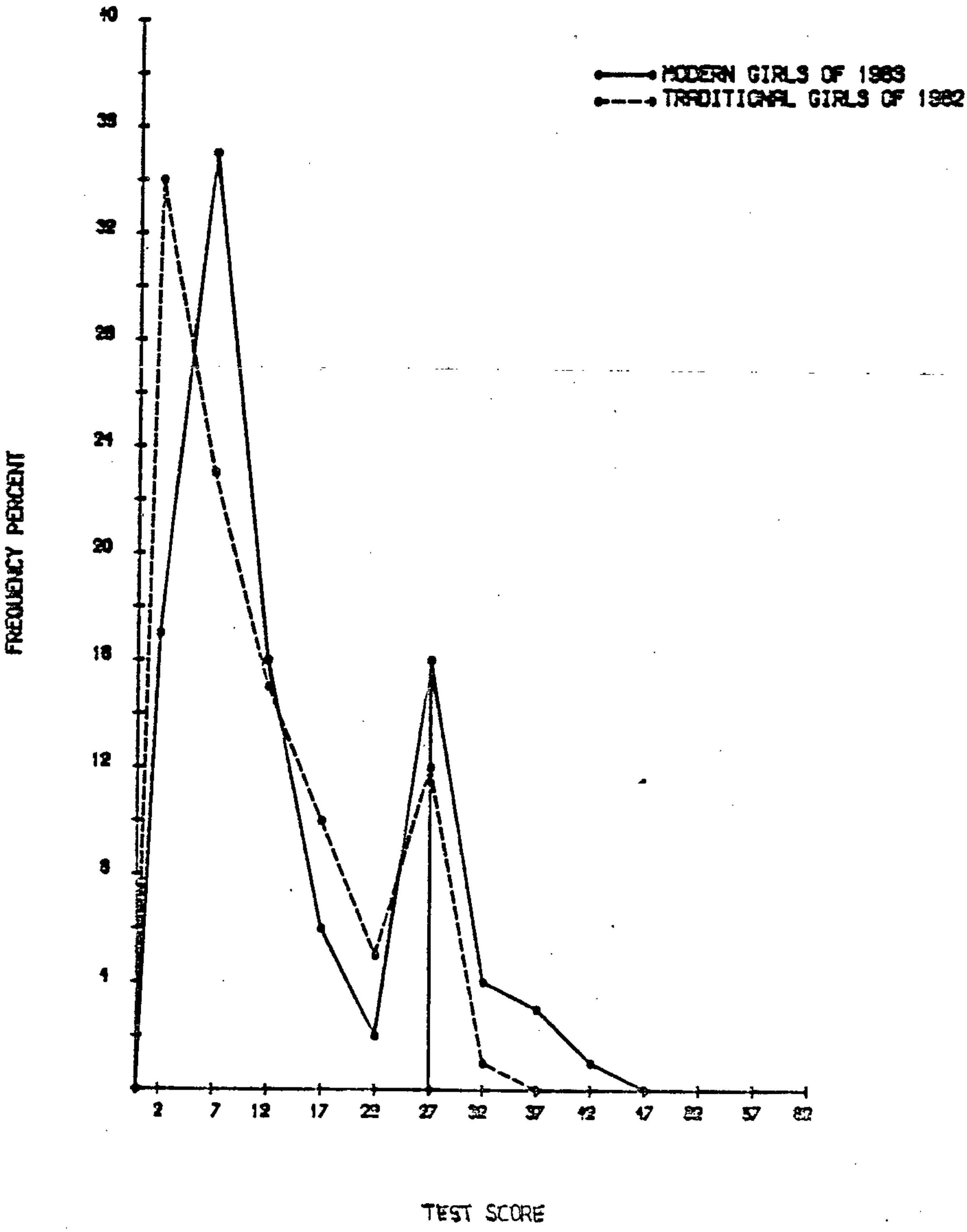
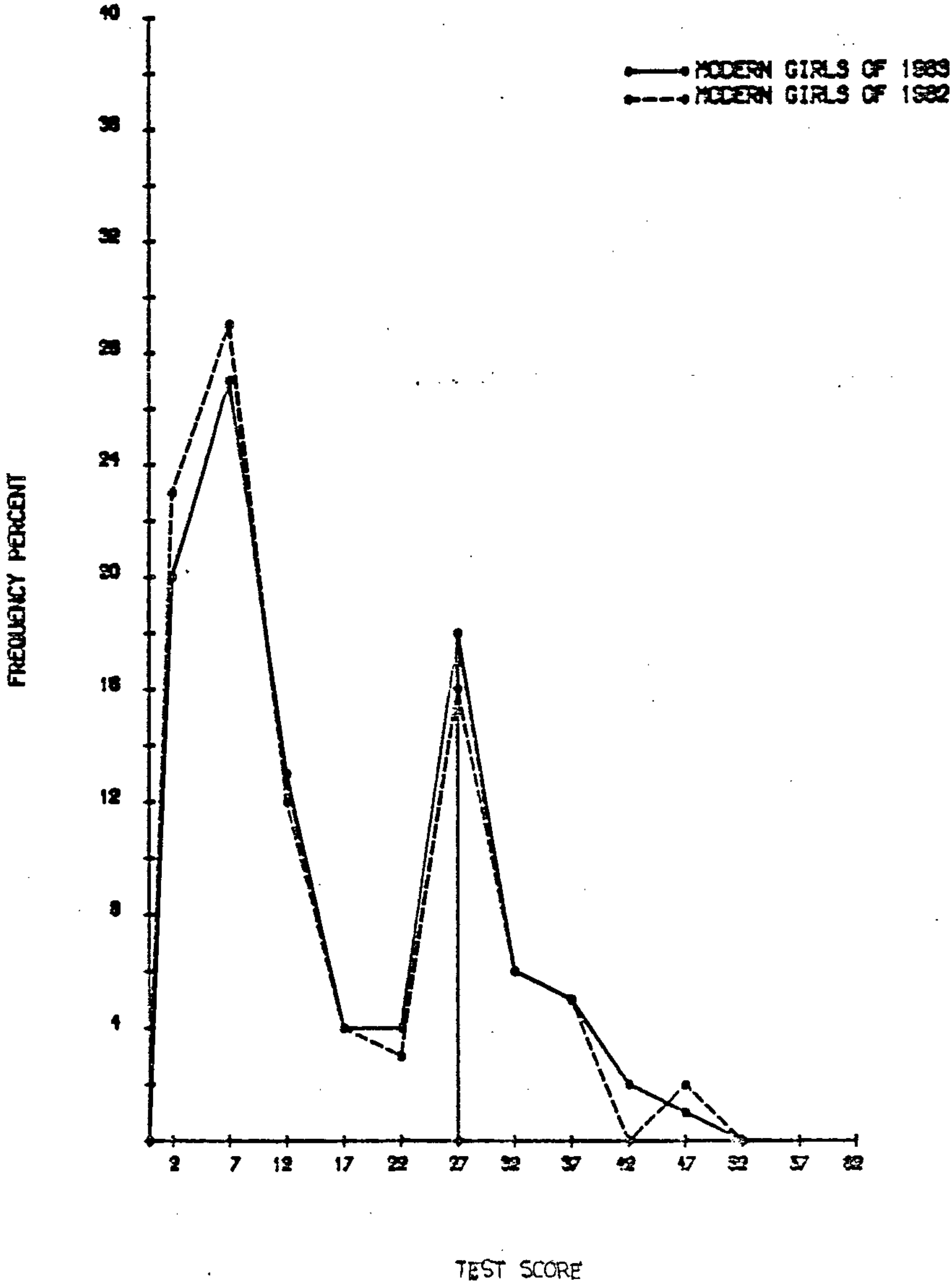


FIGURE 2.14

A RELATIVE FREQUENCY PERCENT POLYGON FOR RESULT OF 'GROUP 4' IN TEST II



CHAPTER THREE

REMEDIAL TEACHING PROJECTS

3.1 INTRODUCTION

The study described in Chapter Two indicated areas of weaknesses in pupils' acquisition of the basic skills and their mastery of the basic procedures. The two projects described in this chapter were an attempt to provide remedial approaches for those weaknesses.

3.2 PROJECT I: Individualised Learning by a Programme of Suitable Exercises

3.2.1 Description

The study in Project I was based on experimental and control groups. The experimental group was given weekly assignments of homework. The work on the assignments started at the beginning of the school year 1983/1984 and lasted for approximately twenty-two weeks.

The contents of the assignments were those of the '10 a day': Metric Edition (1983), by A.L. Griffiths, published by Oliver and Boyd, Edinburgh. This book had been in use for thirteen years when the present author translated it into Arabic in 1983, to be tested in Sudan as a programme of self-instruction.

In Sudan there are six working days in a week with Friday as the weekend holiday. The exercises contained in the book were taken in order, each set of six exercises being prepared separately to form a week's assignment. There was a front page for each assignment on which the name of pupil and the name of pupil's class were written. Directly below, the following statement (translated from Arabic) was written:

> 'These are six exercises. They are your own. Rely on yourself in solving them. Do not allow anybody to assist you to do them or borrow them from you. Work out one exercise per day. Find the answers from your teacher.'

3.2.2 Sampling

The subjects of the selected samples were thirteen-year-old boys and girls of the sixth year of Bakht Er Rida Elementary Schools. As described in Chapter One, teacher training and trials of educational innovations developed by the different departments of the Institute at Bakht Er Rida are evaluated in these schools. Since the trial of this project interfered with the school routine, the elementary schools at Bakht Er Rida were the only schools to which the author could gain access. All six sixth year classes of the schools at Bakht Er Rida were chosen for the experimental and control groups. Since the project put an extra burden on the teacher, the experimental group was self-selected being the classes of those teachers who volunteered.

The sample size was 380 pupils. In the experimental group there were 130 boys and 58 girls, and in the control group there were 117 boys and 75 girls.

3.2.3 Data-Collecting Procedure

The trial material was prepared and sent to the Department of Mathematics at Bakht Er Rida, together with four copies of the answer sheets, one copy for the department and the other three for the teachers of the experimental group classes. Also, the following precautions against any possible transmission of the material from the experimental group were taken. Two letters were sent to the Department of Mathematics, one to the author's colleagues at the department and the other addressed to the experimental group teachers.

The author's colleagues were asked to administer the work as follows:

(1) The assignments should be kept at the Department of Mathematics during and after the trial.

(2) The assignments should be given to the experimental group teachers weekly every Thursday. The following Thursday, the previous assignment should be collected and returned to the department, and at the same time, the experimental group teachers should receive the new ones. In this manner, the department would retrieve all the assignments at the end of the trial.

(3) A common meeting for the experimental and control groups teachers should be held at the Department of Mathematics. In this meeting the aim of the project should be explained to the teachers. The teachers should be urged to co-operate so that the trial would be controlled perfectly.

(4) The project would be evaluated by analysing the mathematics results of the two groups in the National Examinations of March, 1984. These results and the results of the pupils who sat the examination in 1983 should be copied and sent to the author together with a copy of the mathematics examination paper of 1983 and 1984.

The following instructions were given to the experimental group teachers:

1. They would receive a week's assignments from the Department of Mathematics every Thursday. The following Thursday they should give back the assignment of the week just finished and receive the assignment of the next week.
2. They should give the assignments to their pupils on the same day as they receive them.
3. They should read to the pupils the instructions on the front paper of each week's assignment and the pupils should be told to follow these instructions strictly.
4. The pupils should know that the answers for each exercise would be given on the following day.
5. The pupils should know that the assignments would be distributed weekly on Thursday and be collected from them the next Thursday.
6. The pupils should know that in each weekly assignment they should carry out the first exercise on Friday so as to finish the assignment on Wednesday.
7. The teachers should give the answers only by writing them on the board without any further discussion. The assignments covered topics previously taught to the pupils and the majority of these were taught in previous years. On the basis of the answers the pupils could revise their work on the same day before carrying out the next exercise.
8. After giving the pupils the first week's assignment the teachers should follow the schedule shown in Table 3.1.

A report from the Mathematics Department at Bakht Er Rida assured the author that all the instructions to the department and the experimental group teachers were followed strictly. Particularly, the control group had been kept away from the experimental group work.

Table 3.1

SATURDAY TO WEDNESDAY	THURSDAY
Give the pupils the answers for the exercises solved on the previous day.	(1) Give the pupils the exercises solved on Wednesday. (2) Collect from the pupils the assignment of the week just finished. (3) Give the pupils the assignment of the next week.

Possible intervening variables which the study might encounter were the general ability of pupils, their mathematical attainment, the time spent doing mathematics and the ability of the teachers.

Bakht Er Rida Elementary Schools were among those schools involved in the study of Chapter Two. So as mentioned in Chapter Two, the teachers in these schools were recognised by the authorities as equally competent. Also, the schools were not selective. So the pupils' ability variable was systematic over all classes. The variables that could possibly affect the result of the experiment were mathematical attainment, time spent doing mathematics, and teacher motivation. But this last variable was expected to operate systematically over all classes.

3.2.4 Instruments Employed

The instrument employed in the study was the Elementary School Certificate mathematics examinations which pupils sat in March, 1983 and 1984. The National Final Examination was chosen because it could reflect the effect of the individualised learning more realistically than an immediate test. The National Final Examination would test retention and also results based on it would be more convincing to 'public opinion'. The English version of the mathematics examinations of 1983 and 1984 are shown in Appendices L and M.

There were some skills which were not covered by the examinations, such as the skill of converting common fraction to decimal fraction. It is not possible to cover the whole syllabus in a single two-hour examination. This factor reduces the content validity of the examination. But since the total score of the examination, which was 60, is big enough, the content validity would not be affected seriously.

The duration of the examination also reduces the reliability because it is difficult for a 13-year-old pupil to concentrate for two hours.

3.2.5 Analytic Techniques

For the same reason discussed in Chapter Two, the analytic technique adopted in this study is a graphical method. It must be borne in mind that the only data available are the total scores of the pupils. The maximum score of the examination was 60 with a passing score of 30. The unit of analysis of the study was the individual scores.

3.2.6 Results and Discussion

The score distributions in Figures 3.1 to 3.6 again appear to be bimodal. They show the separation between the group of pupils who pass and that of pupils who fail. The artificial dichotomy between the two groups lies at about 50% of the maximum score. The vertical line through the point (32) shows the separation between the two groups.

Figure 3.1 shows the distribution of scores obtained by the experimental and control group boys. It is clear from the figure that, in the group of boys who fail, the area under the graph of the control group is greater than the area under the graph of the experimental group. In contrast, it is clear that, in the group of boys who pass, the area under the graph of the experimental group includes the area under the graph of the control group. The figure shows clearly the superiority of the experimental group.

In numerical terms, the information from Figure 3.1 can be shown in Table 3.2

Table 3.2

Score	< 30	≥ 30
Control group boys	0.75	0.25
Experimental group boys	0.55	0.45

The effect of the individualised learning material is to 'transfer' 20% of the boys from the lower to the upper group.

Figure 3.2 shows the distribution of scores obtained by the experimental and control group girls. In the group of girls who fail there is interaction between the graph of the experimental and control group. However, subtracting the common area under the two graphs and comparing the remaining two areas, it can be seen that the area under the graph of the control group is greater than the area under the graph of the experimental group. This shows that the proportion of the experimental group girls who fail is smaller than the proportion of the control group girls who fail. On the other hand, in the group of girls who pass, it is clear that the area under the graph of the experimental group includes, and is very much bigger than, the area under the graph of the control group.

The information given by Figure 3.2 is summarised in Table 3.3.

Table 3.3

Score	< 30	≥ 30
Control group girls	0.96	0.04
Experimental group girls	0.68	0.32

The effect of the individualised learning material is to 'transfer' 28% of the girls from the lower to the upper group.

Because the experimental group was self-selected this difference in examination performance might simply reflect the motiviation of the teachers. To test this a comparison is made with the 1983 results. Figures 3.3 to 3.6 show the distributions of scores by the experimental and control group pupils in 1984 and scores obtained by their colleagues from the same schools in 1983. Table 3.4 gives a numerical summary of the information gained from Figures 3.3 to 3.6.

Table 3.4 shows four groups of compared pairs. For each compared pair the teachers were the same. The variables which might affect the result were the examination variable and the extra material variable for groups 1 and 2, and the examination variable for groups 3 and 4. Appendices L and M may show that the examination of 1983 was easier than the examination of 1984. The latter contained difficult questions such as Question 1, part 9; Question 3, parts 3 and 4; and Question 6. However, the experimental group pupils in groups 1 and 2 scored higher.

This indicates that the extra material given to the experimental groups was effective despite the relative difficulty of the examination these groups sat. Hard examinations produce unreliable results among poorer pupils. They fail to discriminate accurately between the weak and medium pupils. The results of Groups 3 and 4 show the variation in difficulty in the examinations between 1983 and 1984. Indeed, the pupils of Groups 1 and 3 who sat the 1983 examination show remarkable consistency in performance (see Table 3.4).

Table 3.4

Group	Type of pupil	Proportion scoring <30	Proportion scoring ≥30
1	EXPT. GR. Boys of 1984	0.55	0.45
	Boys of 1983 from same schools	0.63	0.37
2	EXPT. GR. girls of 1984	0.68	0.32
	Girls of 1983 from same schools	0.73	0.27
3	Cont. GR. Boys of 1984	0.75	0.25
	Boys of 1983 from same schools	0.65	0.35
4	Cont. GR. Girls of 1984	0.96	0.04
	Girls of 1983 from same schools	0.81	0.19

Comments

1. In Group 1, there is a difference of 8% in favour of experimental group boys.
2. In Group 2, there is a difference of 5% in favour of the experimental group girls.
3. In Group 3, there is a difference of 10% in favour of the boys of 1983.
4. In Group 4, the girls of 1983 performed much better than the control group girls.

In all, the picture shown in Figures 3.1 to 3.6 and the information given in Tables 3.2, 3.3 and 3.4 indicate the great effect of the individualised learning material on the pupils' mathematical attainment in 1984.

3.3 PROJECT II: Posters Teaching

3.3.1 Description

Project I was administered in the form of tasks for the pupils to carry out according to a scheduled programme. The purpose of Project II was to investigate the teaching potential of posters. The posters under investigation were designed to help pupils understand the basic concepts of area. The main interest was to assess what pupils learn 'by accident'. So while in Project I the pupils were almost compelled to learn, in this project the pupils were allowed to learn when they liked to.

Four posters, Areas 1, Areas 2, Areas 3 and Areas 4 (see Appendix N) were designed and given to the teachers in the classes chosen for the trial. The teachers were asked to place the posters in prominent places in the classrooms. They were also advised that a little care was necessary to avoid any undue pressure on the pupils to study the posters.

3.3.2 Sampling

The subjects of the selected samples were boys and girls of age 8+ and 9+ from five primary schools in the city of Edinburgh. The classes chosen were primary-four and primary-five. The schools were chosen so as to provide variety of social backgrounds. The sample size was about 125 pupils.

Five existing classes were deliberately chosen by the authorities to provide a representative mixture of all levels of intelligence.

The length of time for exhibition of the posters was determined by the class teachers. The duration varied between schools from four to six weeks. At the end of the trial each teacher was asked to complete a questionnaire (see Appendix O). This followed a short interview with the author.

The classroom teacher had more experience and knowledge of his or her children than any other person, so any comments or advice or suggestions that the teacher had about the material would be very beneficial. The teachers' responses are shown below.

3.3.3 Results

Question 1: What do you think of the posters?

Response:

(a) Good. Material at varying level. Areas 2 and 4 (page 2) suited children best. Areas 1, 3 and 4 (see page 1) for younger children.

(b) Good content. Well graded and instruction clear.

(c) Might be useful as a follow-up to a lesson or series of lessons.

(d) Middling. Areas 1, 3 and 4 (page 1) were good, children enjoyed doing them. Areas 2 and 4 (page 2) were difficult to understand but after discussion with me the children made a good attempt at them.

(e) Middling. Middling for basics. Good for reinforcement of teaching. Children liked practical handling situation, especially Areas 2.

Question 2: Did the children take any notice of the posters?

Response:

(a) All took notice. All interested, some more than the others.

(b) Some took notice. Some of them ignored the posters. Children's IQs low. Many have difficulty in reading.

(c) All took notice.

(d) None of them took notice. Perhaps they could be more colourful to make the children take notice.

(e) All took notice.

Question 3: Did you direct the children to look at the posters?

Response:

(a) I directed them. They would not have noticed them if I hadn't.

(b) I directed children. Initially I directed the most able to this material.

(c) I directed the children. The children were very eager to do this, didn't need much encouragement. Worked hard and with great enthusiasm, but probably without understanding. Not many can follow example unaided.

(d) I directed the children. At first, I did not direct them, but eventually I had to.

(e) I directed the children. Directed them after they finished exercise to work on posters as activity.

Question 4: Did the children discuss the posters between themselves?

Response:

(a) Discussed them between themselves and with me. Most discussed with each other. Others asked for help.

(b) Discussed them between themselves. Only two able children discussed material with me. Others tended to tackle it alone and never discussed it.

(c) Discussed them between themselves only. It might have been better not to give answers because once the child has seen the answer, the exercise is finished. They have to be helped to correct their mistakes or learn from answers.

(d) Discussed with themselves and with me. After discussion with myself the children then discussed the posters with each other trying hard to answer the questions.

(e) Discussed them with themselves and with me. Discussed with each other and with me for explanation if unsure what asked. Posters were mainly self-explanatory. Children were encouraged to try for themselves, therefore discussion minimal.

Question 5: Do you think the posters have helped any of your children?

Response:

(a) Have helped some of the children. Helped slower ones. Made better able ones look more carefully at area.

(b) Have helped some of the children. With such low ability it is encouraging to see children's attention being caught. Presented clearly and all extra aids are useful.

(c) Have not helped any of the children. Not explicit enough. Points of exercises need to be made more obvious. Exercises need to be related more to real things.

(d) Have helped all of the children. Some children obviously have a problem with the concept of area, others appear to understand it quite well and therefore enjoyed tackling the posters.

(e) Have helped all the children. They have helped them by reinforcement, by consolidation of what they had previously learned, by presenting abstract ideas in a practical way.

Question 6: Can you suggest other topics which benefit from this approach?

Response:

(a) Volume, shape, symmetry, length, money, fractions.

(b) Length, measurement - material must be made durable.

(c) Not if posters are supposed to take the place of a teacher.

(d) Posters can be used in all topics and areas although children usually need some direction to look and read.

(e) Shape, length work, graphs etc. I would adopt parts of subjects to this approach if I could rather than entire topics. Teacher intervention, control, assessment are important to ensure that children have gained mastery of concepts.

3.3.4 Discussion

The results show that, with the exception of one teacher (see response c), the teachers involved display fairly good attitude towards posters. The comments of the teachers indicate that posters could be used to motivate the children.

In all, what can be drawn from the responses is that the posters were a successful teaching medium for understanding the basic concepts of area. Moreover, the comments of the teachers give encouragement to use posters for the motivation of pupils and reinforcement of learning of other mathematical topics. They suggest, however, that the children should be directed to read and work out the material on the posters. This indicates that teacher intervention is necessary on occasion when the children are seen to be in difficulty. Some teachers found that making the answers available on the posters impaired the child's learning. So, in some situations it may be better not to provide answers on posters and let the teacher give the children the feedback.

3.4. CONCLUSION

The finding of Projects I and II suggest that self-learning material, either as individualised learning programme or as posters, was very useful. From the results of Project I, the difference in favour of each of the experimental groups of boys and girls was striking. So, inasmuch as it seems acceptable that the ability variable of the pupils may contribute to this result, it does not seem reasonable to eliminate the independent variable (the individualised learning material). Furthermore, as was discussed in Chapter Two, it is a general belief that the sex variable is a disadvantage for girls in mathematical attainment. But Table 3.4 shows that the proportion of the experimental group girls who passed the examination of 1984 is greater than the proportion of the control group boys who passed the examination. The difference is 7%. Thus it is evident that the effect of the individualised learning material compensated for the sex difference and left an advantage. In addition, Figures 3.1 and 3.2 show that there are significantly more experimental group girls who obtained high scores than control group boys.

3.5 LIMITATION OF THE STUDY

Other than the limitations accompanying quasi-experimental designs, an additional limitation is perhaps a reduction in validity and reliability of the National Mathematics Examinations. Nevertheless, the favourable results of the experimental groups in Project I, and the results in favour of posters in Project II are encouraging to use the two approaches for the better learning of mathematics.

FIGURE 3.1

A RELATIVE FREQUENCY PERCENT POLYGON
FOR RESULT OF BOYS IN THE EXAMINATION

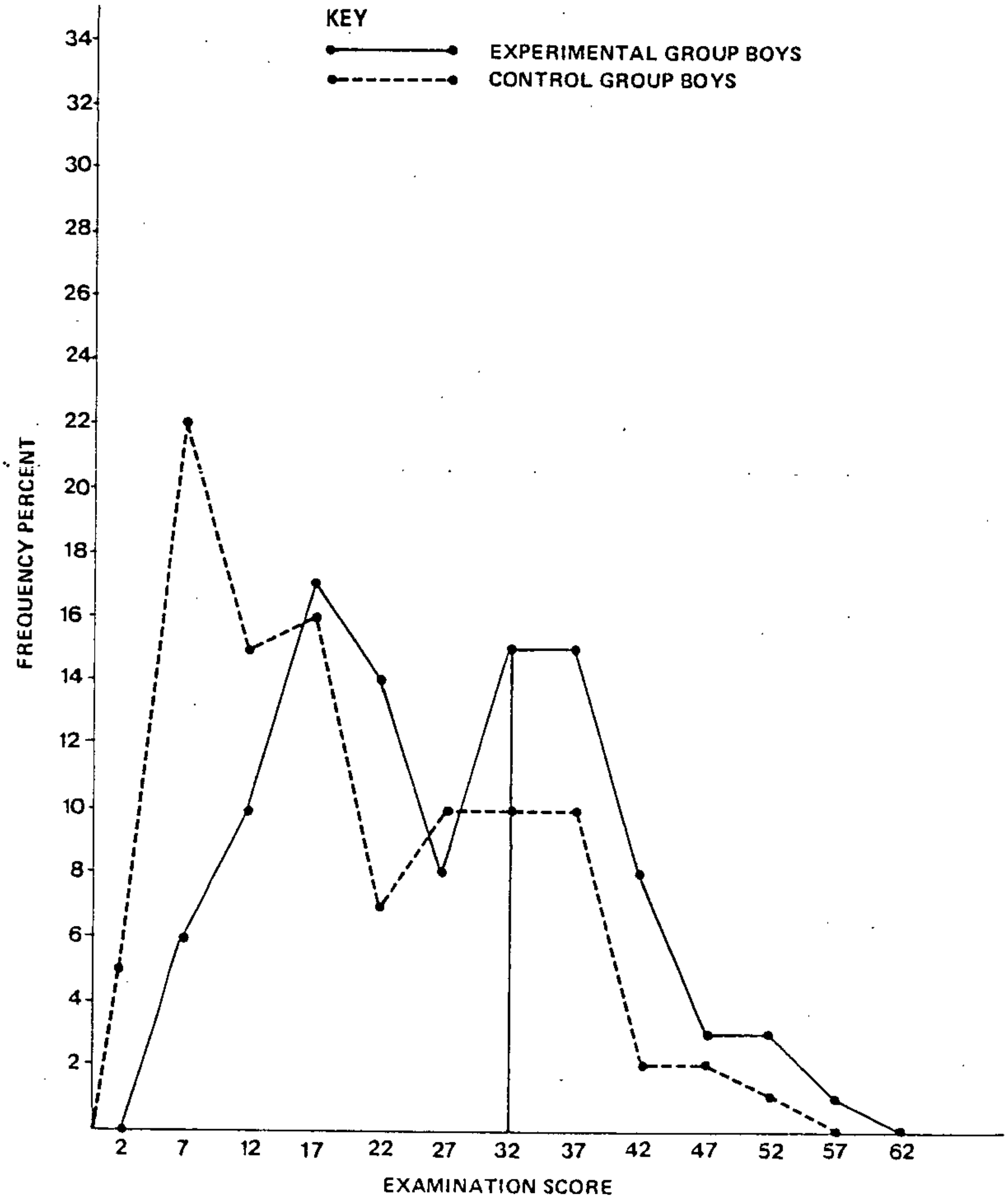


FIGURE 3.2

A RELATIVE FREQUENCY PERCENT POLYGON
FOR RESULT OF GIRLS IN THE EXAMINATION

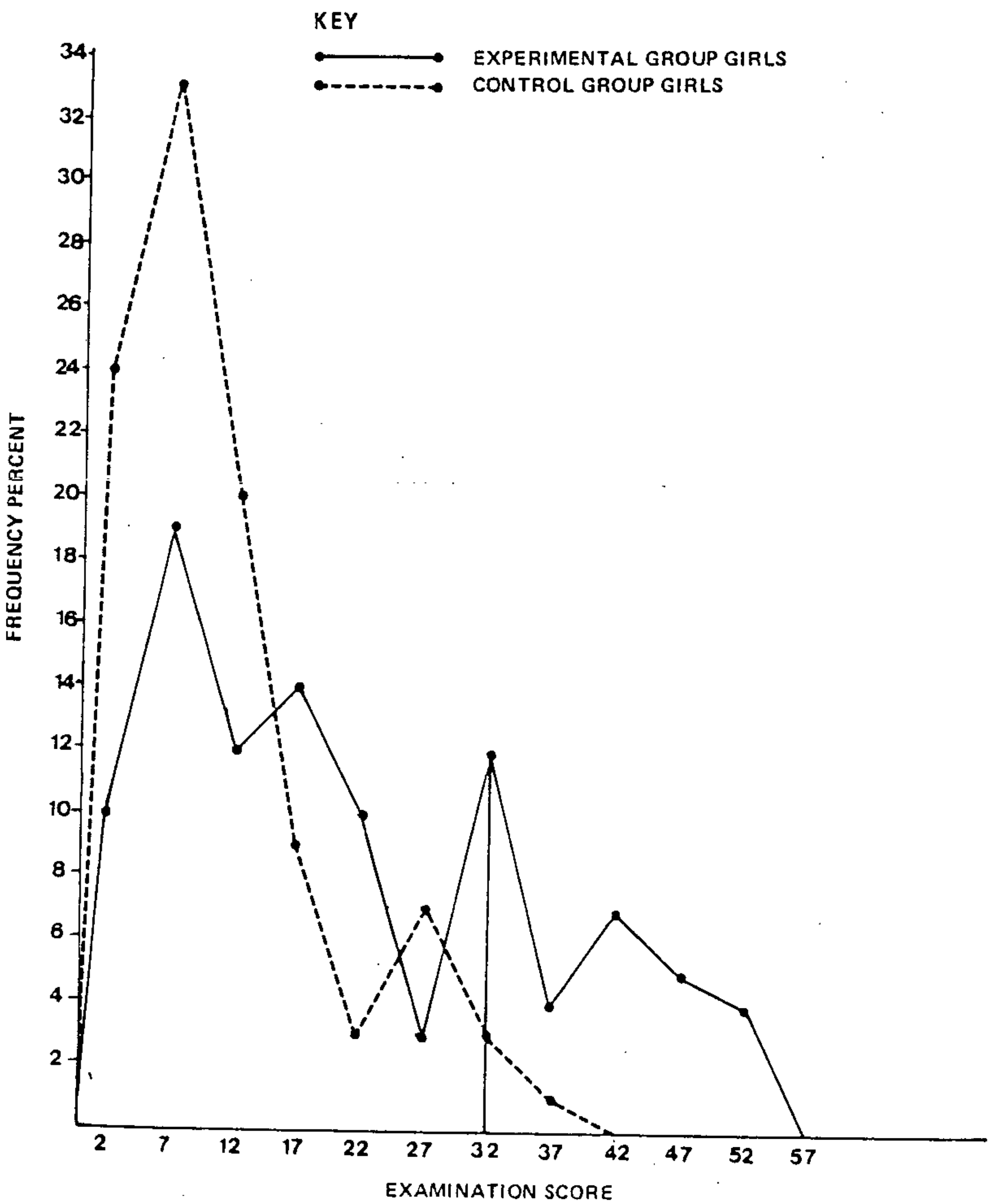


FIGURE 3.3

A RELATIVE FREQUENCY PERCENT POLYGON COMPARING THE RESULT OF THE EXPERIMENTAL GROUP BOYS IN THE NATIONAL EXAMINATION OF 1984 AND THE RESULT OF BOYS IN THE NATIONAL EXAMINATION OF 1983

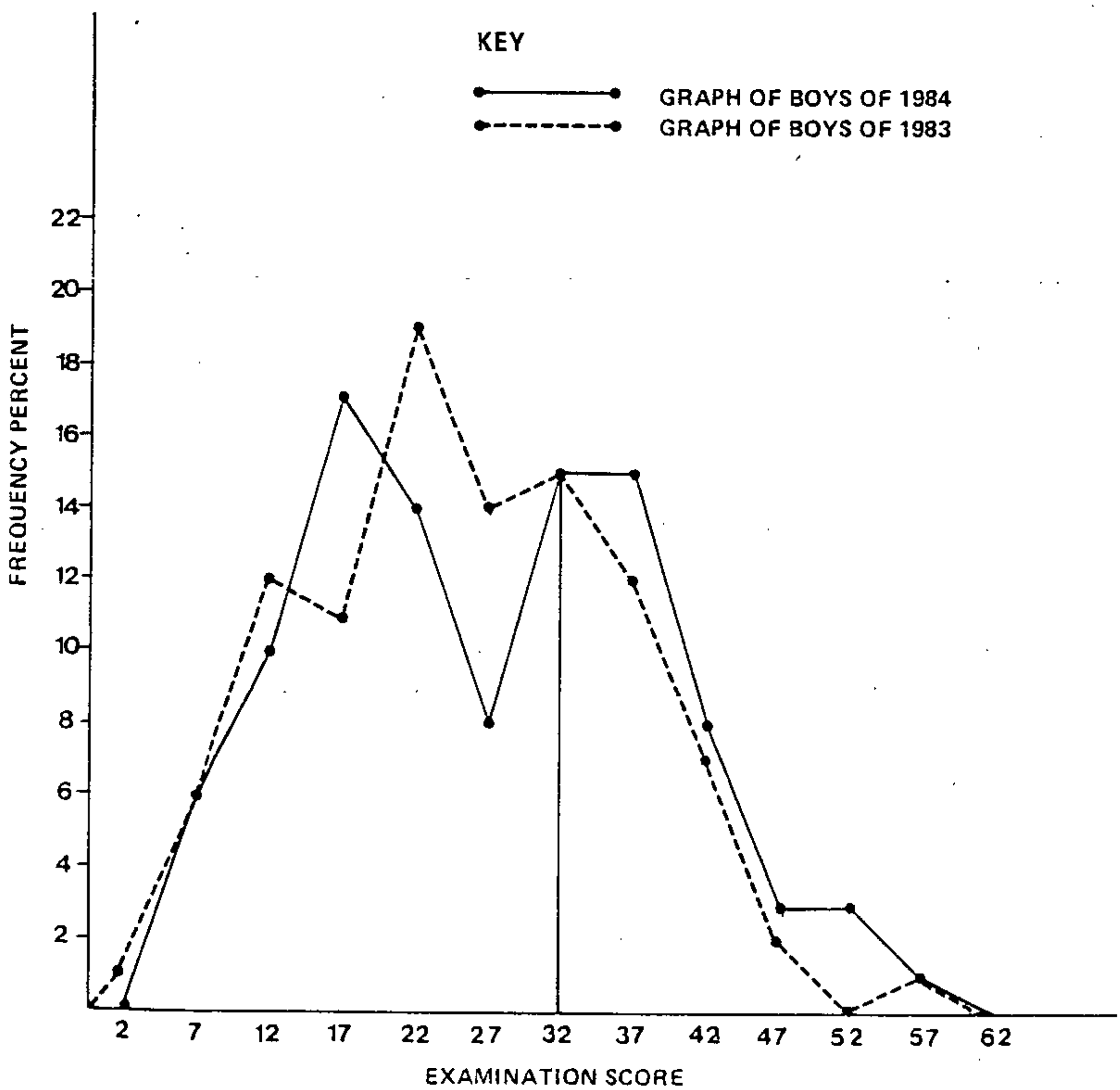


FIGURE 3.4

A RELATIVE FREQUENCY PERCENT POLYGON OF THE RESULT OF THE EXPERIMENTAL GROUP GIRLS IN THE NATIONAL EXAMINATION OF 1984 AND THE RESULT OF GIRLS IN THE NATIONAL EXAMINATION OF 1983

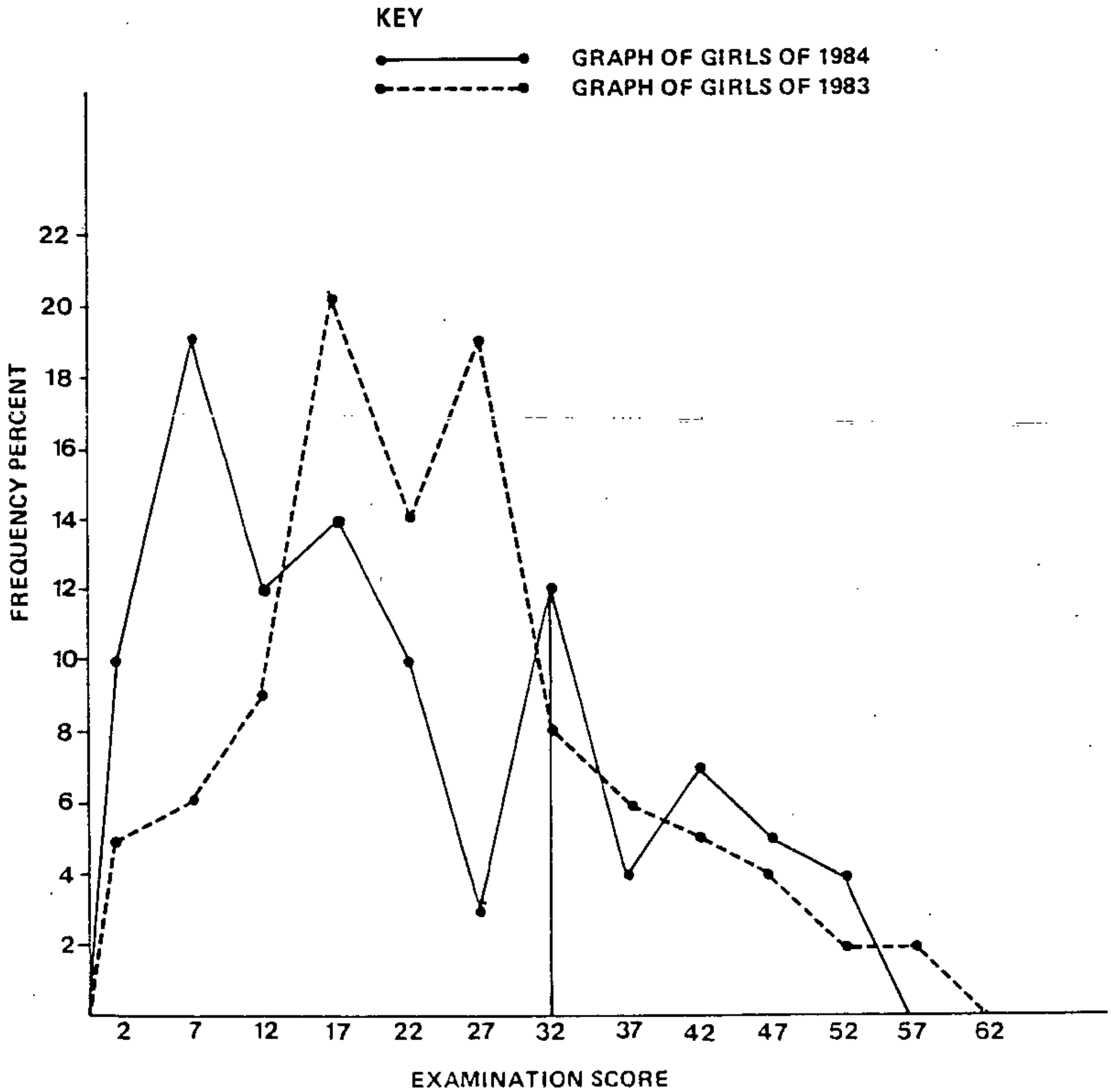


FIGURE 3.5

A RELATIVE FREQUENCY PERCENT POLYGON FOR THE RESULT OF THE CONTROL GROUP BOYS IN THE NATIONAL EXAMINATION OF 1984 AND THE RESULT OF BOYS FROM SAME SCHOOLS IN THE NATIONAL EXAMINATION OF 1983

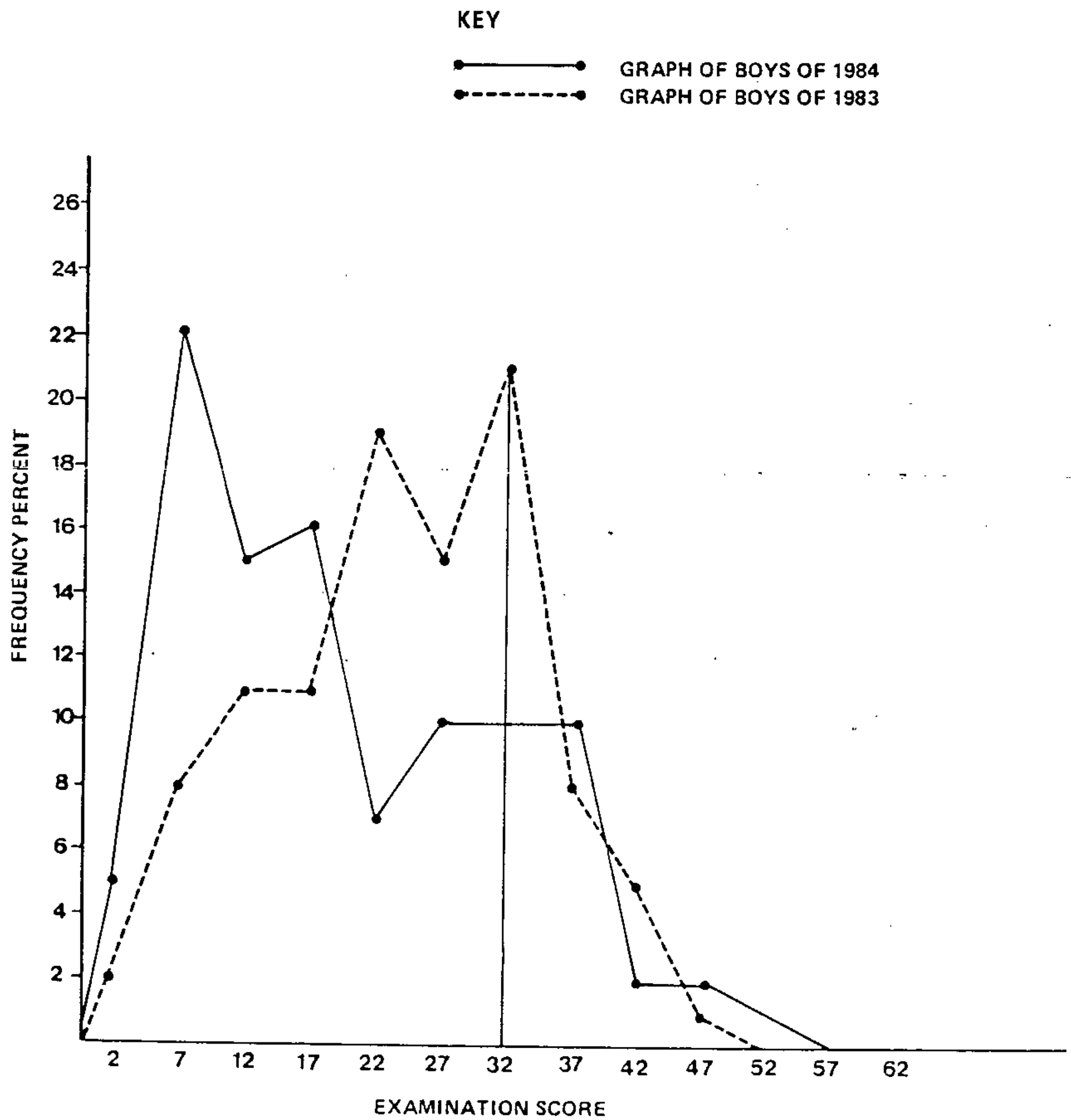
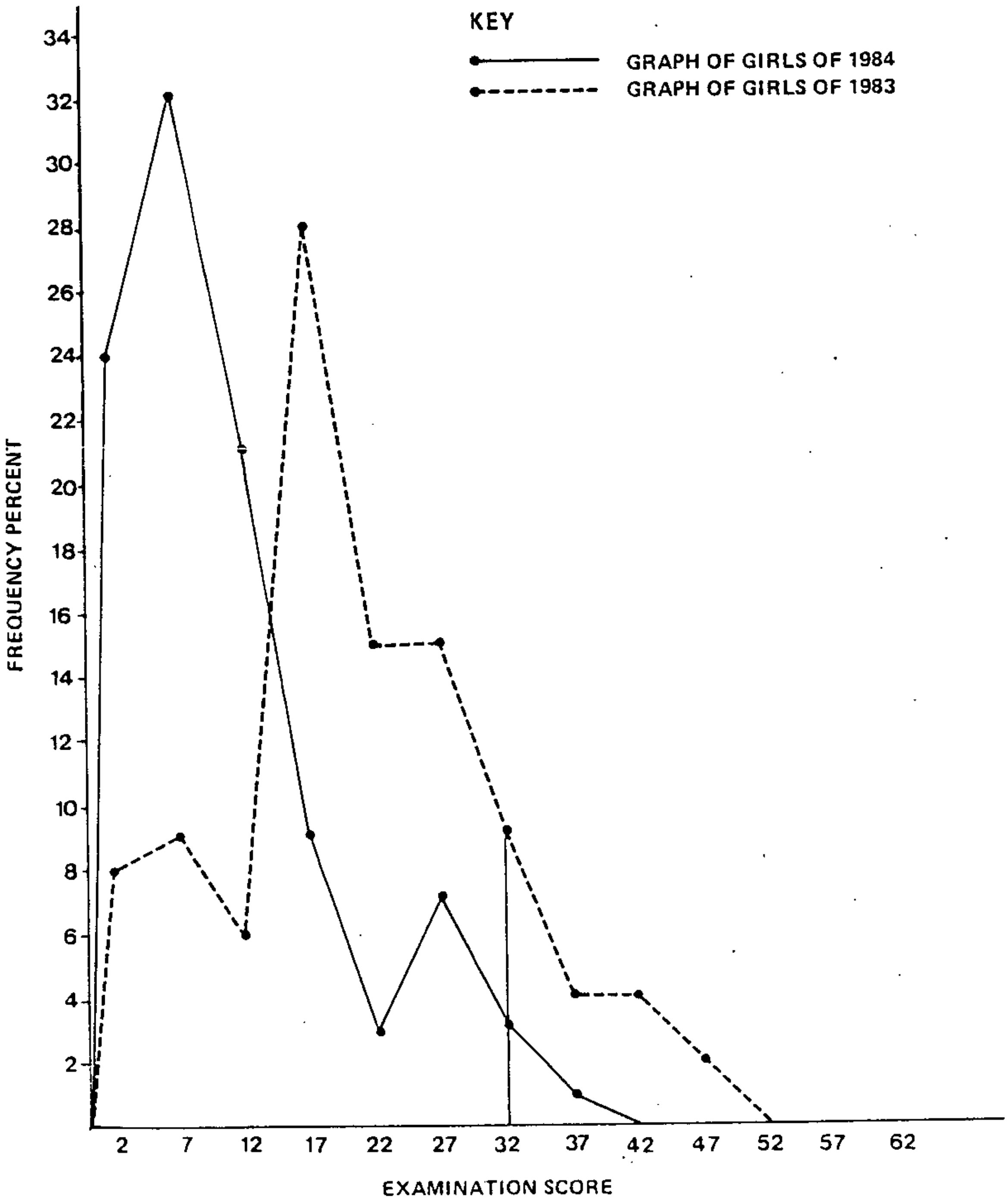


FIGURE 3.6

A RELATIVE FREQUENCY PERCENT POLYGON FOR THE RESULT OF CONTROL GROUP GIRLS IN THE NATIONAL EXAMINATION OF 1984 AND THE RESULT OF GIRLS FROM SAME SCHOOLS IN THE NATIONAL EXAMINATION OF 1983



CHAPTER FOUR

CONCLUSIONS

4.1 SUMMARY

In the first stage of the study described in Chapter Two, the traditional and modern mathematics programmes in the Sudanese elementary schools were compared. The results showed that the pupils following the modern programme performed better in mathematics than those following the traditional programme. This is illustrated by Table 2.3, Diagrams 2.1 and 2.2, and Table 2.5 where it is clear that the advantage of being in the modern programme is greater than the advantage of being a boy.

The second stage was carried out after the modern programme had been used by all schools. Its results confirmed those of the first stage and showed more progress in mathematical attainment. This is shown in Table 2.8. Particularly, Table 2.9 shows good improvement in solving arithmetic operations.

The overall picture shows that the modern programme is more favourable than the traditional one. The study, however, indicated areas of weaknesses in skills and mastery of algorithms. Two remedial projects were undertaken as described in Chapter Three. Project I dealt with individualised learning material carried out as homework assignments, and Project II dealt with posters teaching. Both projects showed favourable results.

In Project I, the result of the examination in 1984 showed that the experimental groups performed far better than the control groups (see Figures 3.1 and 3.2, and Tables 3.2 and 3.3). The comparison of the results in the examinations of 1983 and 1984 showed that the extra material given to the experimental groups of 1984 was effective despite the relative difficulty of the examination in 1984 (see Figures 3.3 to 3.6 and Table 3.4).

In Project II, posters proved to be a successful medium of instruction. This is evident from the teachers' responses to the questionnaire.

4.2 IMPLICATIONS AND SUGGESTIONS

4.2.1 The Mathematics Curriculum in the Elementary Schools

Although the study described in Chapter Two showed that the modern programme was better than the traditional one, still the pupils' performance in solving problems was weak. The results of the pupils in questions 16 and 29 in Test I (see Appendix J) explains this phenomenon. Both questions dealt with subtraction of decimal fractions (see Appendix C), but question 16 was a direct operation and question 29 was a verbal problem. Appendix J shows that the pupils performed well in question 16, but they performed badly in question 29. So, children should have enough time to acquire the ability of constructing strategies for problem-solving. Concrete aids have proved to be helpful (Cockcroft, 1982; Riley et al., 1983). This does not mean that pupils should rely on concrete material all the time. By so doing, mathematics would be detached from its hypothetico-deductive nature. Skemp (1971) states: 'Mathematics is the most abstract, and so the most powerful of all theoretical systems.' Concepts should be presented to the pupils by giving appropriate examples (Skemp, 1971), because examples relate past experience to the present situation and so integrate concepts.

It is noticeable that the mathematical syllabus in the elementary schools is very long. This will have its effect on the quality of teaching and the motivation of pupils to learn mathematics. The teacher needs time to make decisions and create real situations for presenting new lessons. It is a defect of the modern programme that the content of the traditional programme was kept although the teachers complained that the syllabus content of the traditional programme was not suitable for their pupils. This matter is discussed in Chapter One. Indeed, there are some topics which may be beyond the mental capacity of children. An example of these is 'inverse proportion'. According to Piaget et al., understanding of 'direct proportion' can only occur from age 11 to 14, and understanding of 'inverse proportion' can only occur after age 14 (see Karplus et al., 1983; Rupley, 1981). Although the introduction of the modern programme has led to better performance in 'inverse proportional problems', the scores of the pupils were low. So it may be that teaching this topic in the Elementary Level should be reconsidered.

Also, the results of the pupils in items 6, 7 and 9 in Test II (see Appendices D and K) may indicate that the topics tested by these questions are beyond the pupils' mental capacity. The mental capacity of the pupils at this level may not be mature enough to develop appropriate schema to assimilate certain concepts and algorithms. Also priority should be given to the topics which the pupils use in daily situations.

Sudan is a vast country. In parts of it Arabic is not the mother tongue of the inhabitants, so semantic and syntactic structures in the textbooks need to be considered carefully. Towards this end, writing textbooks of mathematics should be semi-centralised. The Mathematics Department at Bakht Er Rida should prepare model textbooks and send them to the different regions in the country. Every region, under the guidance of the models, should prepare its own textbooks differing from the models in the vocabulary chosen. Also, verbal problems should not be introduced in the textbooks until the linguistic structure of the children is well-founded. Particularly, conditional sentences should be avoided, since these need certain cognitive structure for reasoning which will not be developed at the Elementary Level. It may also be helpful that setting mathematics examinations for the Elementary School Certificate be semi-centralised in the same manner as writing textbooks.

To conclude, the following guidelines are quoted from the Report of the Cockcroft Committee (1982):

> 'Mathematics teaching at all levels should include opportunities for:
>
> 1. Exposition by teacher. Questions and answers should constitute a dialogue;
> 2. Discussion between teacher and pupils and between pupils themselves. The ability to say what you mean and mean what you say should be one of the outcomes of good mathematics teaching;
> 3. Appropriate practical work;
> 4. Practice;
> 5. Problem-solving. For many pupils this will require a great deal of discussion and oral work before ... problems can be tackled in written form;
> 6. Investigational work. Investigations ... should start in response to pupils' questions.'

4.2.2 Teacher Training

The ultimate goal of mathematics education is to equip students with adequate mathematical knowledge and an ability to use that knowledge. The development of an appropriate curriculum and the preparation of suitable teaching materials are only part of the educational provision for the child. By far the most important influence on the pupil's progress is the role of the class teacher (Royal Society, U.K., 1976; Fagan and Ponder, 1981).

A competent teacher is one who is well-informed in the subject matter he teaches, has high skill in understanding the child's way of thinking and mode of work, and is capable of relating past experience of the children to the topic he is to present. Moreover, a competent teacher should be a thinker and a good decision-maker (see Bishop, 1976; Newson, 1983; O'Brien, 1976; Turnau, 1976).

One contribution to the improvement of the situation in Sudan, mathematics textbooks should be especially prepared for the Elementary Teacher Training Institutes. The subject matter should be related to the subject matter taught in the Elementary Level. The style of presentation should reflect that of the Elementary Level, but the material should be more sophisticated and supply the student teacher with deeper knowledge. If the teacher was supplied with the same mathematical knowledge as that taught to the pupils he may be less able in understanding the syllabus content he teaches than some of his pupils. Some of the pupils may be more intelligent than their teacher. Ability can be defined as interaction of knowledge and intelligence. So to ensure that the teacher's ability is high enough the knowledge factor should be very high in favour of the teacher. For example, a suitable topic is set theory. Other topics that might be included are matrices, arithmetic of the subsystems of the real numbers and the geometry of the line and plane, following the suggestions of the Cambridge Conference (USA, 1967).

If the teacher has a negative attitude towards mathematics, this will be reflected in his pupils. The student teachers should be taught with methods which stimulate and motivate them at all effective and cognitive levels. Many studies' findings showed that using activity materials results in positive attitude towards mathematics (Squire, Cathcart and Worth, 1981).

In the area of the methodology, recent ideas about didactical training concentrate on training the prospective teachers to acquire the ability to sense the child's behaviour and understanding. Bishop (1983) believes that this can be achieved by 'personal construct of knowledge' which can be acquired by 'role-play' and 'contrasting experience'. Similarly, Wittmann (1984) believes that a training programme should offer to the prospective teachers what he calls 'psychological-didactical studies' which should be taken from 'psychological problems arising from teaching units'. Also, in presenting a new lesson the teacher should create a real learning situation (see Goffree, 1983; Newson, 1983). Teachers of the prospective teachers will have the responsibility of presenting these ideas. Also, the Faculty of Education at the University of Khartoum should train adequately teachers of teachers.

It is very important that the students accepted by the Elementary Teacher Training Institutes have adequate mathematical aptitude. Also, these institutes should be supplied with video-equipment for teaching practice.

Finally, a very important provision to teacher education is in-service training, not as a substitute for pre-service training as practised in Sudan, but as a follow-up to it. Summer or winter courses and seminars can be held for a follow-up education. Also, the In-Service Educational Training Institute, beside its present responsibility for initial in-service training, should arrange a special follow-up in-service training for the mathematics teachers by sending assignments by mail to the educational centres in the different parts of the country. These centres then, in turn, distribute the assignments to schools under their authority.

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APPENDICES

APPENDIX A

ATTITUDE SCALE

Name of School .... Name of Pupil ....

Age of Pupil .... Number of years spent in School ......

Repeater/Not Repeater (Delete as appropriate)

DIRECTIONS: 1. Please answer all the questions carefully. Please do not hesitate to show your true attitude because your true attitude is of vital importance to this study. Thank you for your cooperation.

2. In each of the following questions there are five statements each of which expresses certain attitude towards mathematics. Choose the statement which expresses an attitude nearest to yours. Then write the number of this statement between the parentheses on the left hand side.

( ) A. Mathematics is a subject which

1. I like most.
2. I like.
3. I don't know whether I like it or not.
4. I don't like.
5. I don't like at all.

( ) B. Mathematics is a subject which

1. I hate most.
2. I hate.
3. I can't say whether I hate or not.
4. is enjoyable.
5. is my most enjoyable subject.

( ) C. Mathematics is a subject which

1. is very interesting.
2. is interesting.
3. I can't say whether it is interesting or not.
4. is not interesting.
5. is not interesting at all.

( ) D. Mathematics is a subject which

1. is very dull.
2. is dull.
3. I can't say whether it is dull or not.
4. is lively.
5. is very lively.

( ) E. I find Mathematics

1. very easy.
2. easy.
3. such a subject which I can't say whether it is easy or not.
4. difficult.
5. very difficult.

( ) F. If I were good at mathematics

1. it would not help me to find a good job in any way.
2. it would not help me to find a good job.
3. I can't say whether it would help me to find a good job.
4. it would help me to find a good job.
5. it would certainly help me to find a good job.

( ) G. Mathematics is a subject which

1. is very useful in daily life.
2. is useful in daily life.
3. I can't say whether it is useful in daily life.
4. is not useful in daily life.
5. is not at all useful in daily life.

( ) H. Mathematics is a subject which

1. is not at all useful for study of any other subject.
2. is not useful for study of any other subject.
3. I can't say whether it is useful for study of some other subjects.
4. is useful for study of some other subjects.
5. is very useful for study of some other subjects.

APPENDIX B

ATTITUDE SCALE

Name of School .... Name of Pupil ....

Age of Pupil .... Number of years spent in School ....

Repeater/Not Repeater (Delete as appropriate)

DIRECTIONS: 1. Please answer all the questions carefully. Please do not hesitate to show your true attitude because your true attitude is of vital importance to this study. Thank you for your cooperation.

2. Opposite to each of the following questions you find two statements each of which expresses an attitude towards some of your school subjects. You find the first statement in the first column and the second statement in the last column. For each question write under each subject the letter of the column in which you find the statement which expresses an attitude nearest to yours.

Example: Suppose that one of the pupils likes Islamic Education and Sports but he doesn't like Art. Then he will write a and b under the three subjects as follows:

Question	Column a	Islamic Education	Sports	Art	Column b
1	I like it	a	a	b	I don't like it

Now, in the following diagram write a/b in the columns of subjects according to your attitude towards each subject.

Question	Column a	Arabic Lang.	Science	History	Maths.	Geography	Column b
1	I like it						I don't like it
2	Boring						Interesting
3	Most pupils understand it well						Few pupils understand it
4	I find it dull						I find it lively
5	It seems clear						It seems confusing
6	I don't enjoy it						I enjoy it
7	I need it in daily life						I don't need it in daily life
8	I find it difficult						I find it easy

APPENDIX C

Sudan
Ministry of Education and Guidance

University of Edinburgh
Department of Mathematics

Pupil's Attainment Test I - Time: 60 Minutes

Name of School .... Name of Pupil ....

DIRECTIONS: Please answer all the questions. Ruler and compasses are required for question 31 and 32.

In the following questions you are not required to show your working.
Write the answer between the parentheses at the right hand side of the page.

A N S W E R S

1. From the following numbers copy between the parentheses which is a fraction:

   $\frac{8}{9}$, 5 , $\frac{4}{2}$, 24 , $\frac{7}{1}$, $\frac{21}{4}$ ... ... ( ) 1

2. If $\frac{2}{3} = \frac{1}{3}$ ☐ 2, which symbol from +, x, −, ÷ is missing? ... ... ( ) 2

3. If 5 x 1 = ☐, what is the missing number? ... ... ( ) 3

4. If 5 x 0 = ☐, what is the missing number? ... ... ( ) 4

5. If 5 + 0 = ☐, what is the missing number? ... ... ( ) 5

6. If $\frac{5}{7}$ x ☐ = 1, what is the missing number? ... ... ( ) 6

7. If $\frac{5}{7}$ x ☐ = 0, what is the missing number? ... ... ( ) 7

ANSWERS

8. If $\frac{5}{7} \times \square = \frac{5}{7}$, what is the missing number? ... ... ( ) 8

9. If $1 : 4 = \square : 8$, what is the missing number? ... ... ( ) 9

10. The ages of Muhammad, Hasan and Ali are in the ratio 3 : 2 : 1.

a) If Hasan is six years old, how old is Ali? .. .. ( ) 10a

b) Who is the eldest? ... ... ( ) 10b

In the following questions you are required to show your working in the space provided.

11. If $\frac{3}{7} : \frac{1}{14} = \square : 1$, what is the missing number? ( ) 11

12. What is the value of : $\frac{3}{4}$ of $\frac{5}{8}$? ( ) 12

13. $\frac{4 \times 9 - 6}{3} =$ ( ) 13

14. $\frac{5}{6} + \frac{1}{8} - \frac{1}{4} =$ ( ) 14

15. Add :
$$\begin{array}{r} 0.0995 \\ \underline{61.0200} \\ \hline\hline \end{array}$$
( ) 15

16. Subtract :
$$\begin{array}{r} 51.040 \\ \underline{0.632} \\ \hline\hline \end{array}$$
( ) 16

ANSWERS

17. $1\frac{2}{3} \times 5 =$ ( ) 17

18. $9.04 \times 3 =$ ( ) 18

19. $0.015 \times 0.7 =$ ( ) 19

20. $\frac{1}{5} \div \frac{2}{7} =$ ( ) 20

21. $8.126 \div 2 =$ ( ) 21

22. $4.32 \div 0.2 =$ ( ) 22

23. By factorization find $\sqrt{196}$. ( ) 23

24. If the area of a square is 144 sq. cm , what is its perimeter? ( ) 24

25. If the area of a rectangle is 34.2 sq. cm , and its length is 6 cm , what is its breadth? ( ) 25

26. Convert $\frac{3}{8}$ into a decimal fraction. ( ) 26

27. Mustafa has £20. If Safiya has $\frac{3}{5}$ as much as Mustafa has, how much money has Safiya? ( ) 27

A N S W E R S

28. A bottle contains $\frac{3}{4}$ litre of lemonade.
If $\frac{1}{3}$ litre is drunk, how much remains? ( ) 28

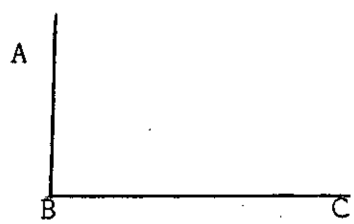
29. A boy is now 0.09m taller than he was last year. If his height is now 1.42m , what was it last year? ( ) 29

30. What is the total number of goals a footballer scored in 60 local matches and 10 international matches if the ratio of the number of goals to the number of matches he played was

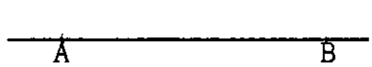
3:2 for the local matches
and 1:1 for the international matches? ( ) 30

To answer the following two questions all lines and curves should be shown clearly.

31. In the figure at the right, angle $\angle ABC$ is a right angle. Using a ruler and a pair of compasses only, draw $\angle CBD = 45°$



32. On the line AB shown below draw $\angle ABC = 60°$ using a ruler and a pair of compasses only.



APPENDIX D

Sudan
Ministry of Education and Guidance

University of Edinburgh
Department of Mathematics

Pupil's Attainment Test II - Time : 60 minutes

Name of School .... Name of Pupil ....

DIRECTIONS: Please answer all the questions. For questions 1 and 2(a) just write the answer between parentheses at the right hand side of the page. For the rest of the questions you are required to show your working in the space provided and then write the answer between the parentheses.

ANSWERS

1. (a) Write 12% as a common fraction ... ( ) 1(a)

   (b) Write 0.23 as a percentage... ... ( ) 1(b)

2. (a) Write the ratio 2 : 6 : 4 in the simplest form. ... ... ( ) 2(a)

   (b) Write the ratio $\frac{1}{4} : \frac{1}{3} : \frac{1}{2}$ in the simplest form. ... ... ( ) 2(b)

   (c) The heights of three trees are 2m , 1m and $1\frac{1}{2}$m , successively. Write in the same order the simplest form of the ratio of these heights. ( ) 2(c)

3. 6 men bought a boat for £1200. If they shared the money equally, how much money paid by four of them? ( ) 3

ANSWERS

4. If a man works 5 hours per day, he will complete his work in 6 days. How long must he work per day to finish his work in 4 days? ( ) 4

5. The figure below shows a car and a lorry travelling in the same direction and with the same speed, the car following the lorry.

If the car was to increase its speed by 10km/hour, it would overtake the lorry after 6 minutes. How long would the car take to overtake the lorry if it increased its speed by 15km/hr.? ( ) 5

6. Find $\sqrt{17}$ correct to two decimal places. ( ) 6

7. (a) In the parentheses write the rule by which you find the circumference of a circle. ( ) 7(a)

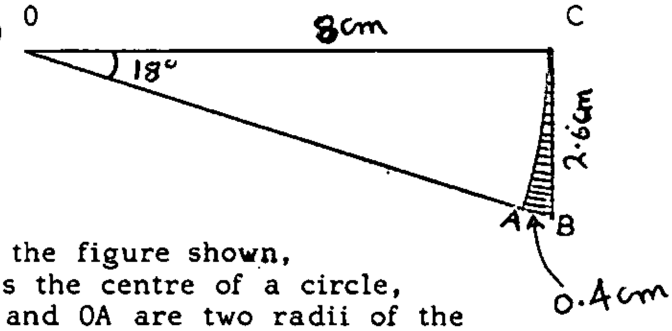
(b) If the circumference of a circle is 11cm, find its radius (Take $\pi \simeq \frac{22}{7}$) ( ) 7(b)

8. A dealer bought a chair for £40. He later sold it, but made a 25% loss. What was his loss in pounds? ( ) 8

ANSWERS

9. (a) In the space below write the rule by which you find the length of an arc of a circle.

(b)



In the figure shown, 0 is the centre of a circle, OC and 0A are two radii of the circle. OC = 8cm and $\angle AOC = 18°$. Calculate the length of the arc AC correct to one decimal place. (Take $\pi \simeq 3.14$). ( ) 9(b)

(c) In the figure above, AB = 0.4cm, BC = 2.6cm. Calculate the perimeter of the shaded figure ABC. ( ) 9(c)

10. Omar sold his car for £4200. If there was a decrease of 30% of its original value, what was the original value? ( ) 10

11. Omar sold his car for £4200. If there was an increase of 100% of its original value, what was the original value? ( ) 11

12. Convert $\frac{1}{1000}$ to a percentage. ( ) 12

APPENDIX E

TESTS SYLLABUS

I. Fractions:

A. Addition, Subtraction, Multiplication and Division of Common and Decimal Fractions;

B. Verbal Problems involving the four operations on Common and Decimal Fractions;

C. Transformation of Common Fractions to Decimal Fractions and vice versa;

D. Simplification of Common Fractions (Reduction to simplest form).

II. Construction:

A. Drawing of Angles by ruler and protractor;

B. Drawing of Circle of known radius with compass;

C. Bisection of Angle and Line-Segment by compass;

D. Drawing of Triangle and of Perpendicular Bisector of Base of Equilateral and Isosceles Triangle by compass;

E. Drawing of Angles of magnitudes: 60°, 90°, 30°, 45°, 15°, 75° by compass;

F. Drawing of Parallelogram if: (1) two sides and angle are known; (2) two sides and a diagonal are known;

G. Drawing of Rhombus if two diagonals are known.

III. Ratio and Proportion:

A. Ratio of Fraction to Fraction;

B. Verbal Problems on Ratio;

C. Comparison between more than two quantities;

D. Verbal Problems on Direct and Inverse Proportion.

IV. Square Roots:

A. Finding square roots of Natural Numbers by Factors;

B. Finding square roots by approximation.

V. Circle:

A. Calculation of Radius and circumference of circle;

B. Calculation of Length of Arc of Circle.

VI. Percentages:

A. Transformation of common and decimal fractions to percentage forms;

B. Verbal problems on percentage:

(1) Finding increase and decrease percent,

(2) Calculation of original value if value after variation and percentage of variation are known.

APPENDIX F

THE TOPICS COVERED BY TESTS I & II TOGETHER WITH THEIR WEIGHTS

TOPICS	WEIGHT PERCENT
PERCENTAGES	17.5
COMMON FRACTIONS	14
DECIMAL FRACTIONS	14
DIRECT & INVERSE PROPORTIONS	12
RATIOS	11
GEOMETRIC CONSTRUCTIONS	9
THE RULE: Length of Arc = $\frac{2\pi rQ}{360}$	5.5
SQUARE ROOT BY APPROXIMATION	5
THE RULE: Circumference of circle = $2\pi r$	5
SQUARE ROOT BY FACTORISATION	4
MULTIPLICATIVE INVERSE & ZERO	3

APPENDIX G

FACILITY VALUES OF TEST I

QUESTION	SCORE	F.V. of 'TD' BOYS *	F.V. of 'MD' BOYS
1	1	66 percent	65 percent
2	½	42 "	59 "
3	½	99 "	92 "
4	½	95 "	96 "
5	½	92 "	85 "
6	½	65 "	74 "
7	½	87 "	87 "
8	½	83 "	90 "
9	½	90 "	86 "
10	1	46 "	53 "
11	1½	33 "	34 "
12	1½	31 "	19 "
13	2	47 "	58 "
14	2	62 "	39 "
15	1	89 "	97 "
16	1½	81 "	84 "
17	1½	58 "	51 "
18	1	80 "	64 "
19	1½	52 "	48 "
20	1	56 "	64 "
21	1	53 "	54 "
22	2	22 "	36 "
23	1½	49 "	65 "
24	2½	24 "	13 "
25	2	35 "	28 "
26	2	29 "	18 "
27	2	52 "	27 "
28	2½	39 "	19 "
29	2	38 "	29 "
30	3	7 "	11 "
31	5	35 "	65 "
32	4	41 "	66 "

* F.V. = FACILITY VALUE

FACILITY VALUES OF TEST I (Cont'd)

QUESTION	SCORE	F.V. of 'TD' GIRLS	F.V. of 'MD' GIRLS
1	1	50 percent	37 percent
2	½	68 "	81 "
3	½	93 "	98 "
4	½	84 "	97 "
5	½	88 "	89 "
6	½	40 "	81 "
7	½	79 "	97 "
8	½	66 "	82 "
9	½	53 "	86 "
10	1	35 "	44 "
11	1½	22 "	46 "
12	1½	41 "	33 "
13	2	23 "	61 "
14	2	39 "	38 "
15	1	90 "	95 "
16	1½	60 "	70 "
17	1½	46 "	56 "
18	1	59 "	72 "
19	1½	39 "	53 "
20	1	44 "	62 "
21	1	33 "	59 "
22	2	11 "	20 "
23	1½	22 "	57 "
24	2½	7 "	23 "
25	2	16 "	41 "
26	2	14 "	37 "
27	2	28 "	44 "
28	2½	19 "	26 "
29	2	19 "	27 "
30	3	4 "	5 "
31	5	5 "	39 "
32	4	19 "	61 "

APPENDIX H

FACILITY VALUES OF TEST II

QUESTION	SCORE	F.V. of 'TD' BOYS	F.V. of 'MD' BOYS
1	2	67 percent	86 percent
2	5	38 "	39 "
3	4	39 "	43 "
4	4	25 "	44 "
5	4	14 "	28 "
6	5	47 "	21 "
7	5	29 "	27 "
8	4	36 "	38 "
9	$5\frac{1}{2}$	14 "	20 "
10	$4\frac{1}{2}$	7 "	43 "
11	$4\frac{1}{2}$	6 "	39 "
12	$2\frac{1}{2}$	36 "	33 "
QUESTION	SCORE	F.V. of 'TD' GIRLS	F.V. of 'MD' GIRLS
1	2	48 percent	86 percent
2	5	29 "	36 "
3	4	29 "	33 "
4	4	28 "	25 "
5	4	15 "	22 "
6	5	16 "	20 "
7	5	18 "	21 "
8	4	34 "	36 "
9	$5\frac{1}{2}$	9 "	24 "
10	$4\frac{1}{2}$	6 "	24 "
11	$4\frac{1}{2}$	6 "	21 "
12	$2\frac{1}{2}$	20 "	9 "

APPENDIX I

VARIOUS TESTED SKILLS IN TESTS I & II COLLECTIVELY

A. Basic Definitions:

(1) Recognition of Fractions;

(2) Identity Element of Addition;

(3) Identity Element of Multiplication;

(4) Multiplication by Zero;

(5) The Multiplicative Inverse;

(6) The Meaning of Ratio;

(7) The Meaning of Fraction of an Amount.

B. Arithmetical Skill:

(1) Operations:

(a) Multiplication of a fraction by a natural number ($\neq 0$);

(b) Simplification of ratio (i.e. to express its terms as natural numbers which are relatively prime);

(c) Finding a Ratio in terms of fractions and expressing it in simplest form;

(d) Simplification of Fractions;

(e) Addition and Subtraction of Common Fractions;

(f) Addition and Subtraction of Decimal Fractions;

(g) Multiplication of Common Fractions;

(h) Multiplication of Decimal Fractions;

(i) Division of Common Fractions;

(j) Division of Decimal Fractions;

(k) Conversion of Common Fractions to Decimal Fractions;

(l) Conversion of Fractions to percentages;

(m) Finding square root of a natural number (≠0) by factorisation;

(n) Finding square root of a natural number (≠0) by approximation.

2. Problems Involving:

(a) Division of Decimal Fractions;

(b) Understanding the meaning of fraction;

(c) Subtraction of Common Fractions;

(d) Subtraction of Decimal Fractions;

(e) Finding square root of a natural number (≠0) by Factorisation;

(f) Simple Unitary Method;

(g) Calculation of Arc of a Circle and Perimeters of Figures.

C. <u>Algebraic Thinking:</u>

Problems involving:

(1) Inverse Proportion;

(2) Subject of Formula;

(3) Increase and Decrease percent involving proportion;

(4) Ratio (applying direct proportion).

D. <u>Geometric Construction:</u>

(1) Skill of Drawing the angle 45° by bisecting right angle;

(2) Skill of Drawing the angle 60° by drawing isosceles triangle on a given line.

APPENDIX J

FACILITY VALUES OF THE FOUR GROUPS OF PUPILS IN TEST I

QUESTION		FACILITY VALUE			
		GROUP 1		GROUP 2	
NO.	SCORE	'TD' BOYS of 1982	'MD' BOYS of 1983	'MD' BOYS of 1982	'MD' BOYS of 1983
1	1	64 per cent	66 per cent	65 per cent	43 per cent
2	½	43 "	62 "	59 "	58 "
3	½	96 "	95 "	93 "	97 "
4	½	95 "	96 "	96 "	95 "
5	½	94 "	90 "	81 "	73 "
6	½	63 "	70 "	71 "	63 "
7	½	88 "	86 "	88 "	86 "
8	½	80 "	84 "	89 "	81 "
9	½	91 "	92 "	87 "	82 "
10	1	46 "	54 "	55 "	58 "
11	1½	31 "	40 "	32 "	45 "
12	1½	32 "	30 "	19 "	27 "
13	2	45 "	75 "	61 "	81 "
14	2	62 "	61 "	39 "	57 "
15	1	89 "	96 "	97 "	96 "
16	1½	80 "	85 "	84 "	89 "
17	1½	57 "	67 "	51 "	70 "
18	1	77 "	80 "	67 "	86 "
19	1½	53 "	51 "	48 "	67 "
20	1	56 "	73 "	62 "	84 "
21	1	54 "	62 "	53 "	70 "
22	2	21 "	41 "	37 "	56 "
23	1½	49 "	60 "	63 "	59 "
24	2½	21 "	26 "	13 "	27 "
25	2	34 "	42 "	28 "	49 "
26	2	26 "	40 "	18 "	46 "
27	2	52 "	30 "	27 "	23 "
28	2½	38 "	39 "	20 "	41 "
29	2	37 "	39 "	28 "	45 "
30	3	6 "	18 "	13 "	18 "
31	5	33 "	67 "	65 "	66 "
32	4	42 "	66 "	65 "	66 "

FACILITY VALUES OF THE FOUR GROUPS OF PUPILS

IN TEST I (Cont'd):

QUESTION		FACILITY VALUE			
		GROUP 3		GROUP 4	
NO.	SCORE	'TD' GIRLS of 1982	'MD' GIRLS of 1983	'MD' GIRLS of 1982	'MD' GIRLS of 1983
1	1	48 per cent	72per cent	39 per cent	76 per cent
2	½	68 "	67 "	81 "	75 "
3	½	92 "	100 "	96 "	100 "
4	½	84 "	93 "	95 "	94 "
5	½	89 "	88 "	90 "	90 "
6	½	41 "	75 "	81 "	80 "
7	½	78 "	82 "	96 "	94 "
8	½	68 "	84 "	82 "	87 "
9	½	54 "	71 "	87 "	90 "
10	1	32 "	45 "	43 "	57 "
11	1½	23 "	28 "	46 "	47 "
12	1½	40 "	37 "	32 "	31 "
13	2	22 "	57 "	61 "	73 "
14	2	39 "	42 "	38 "	52 "
15	1	89 "	88 "	95 "	92 "
16	1½	59 "	72 "	70 "	81 "
17	1½	46 "	64 "	57 "	65 "
18	1	59 "	64 "	71 "	70 "
19	1½	39 "	51 "	53 "	53 "
20	1	44 "	68 "	63 "	69 "
21	1	35 "	55 "	59 "	57 "
22	2	12 "	30 "	20 "	30 "
23	1½	20 "	52 "	57 "	56 "
24	2½	8 "	17 "	23 "	22 "
25	2	16 "	39 "	41 "	40 "
26	2	14 "	38 "	36 "	35 "
27	2	28 "	28 "	45 "	31 "
28	2½	19 "	24 "	27 "	32 "
29	2	19 "	26 "	27 "	29 "
30	3	4 "	10 "	5 "	11 "
31	5	6 "	50 "	40 "	61 "
32	4	19 "	60 "	62 "	63 "

APPENDIX K

FACILITY VALUES OF THE FOUR GROUPS OF PUPILS IN TEST II

QUESTION		FACILITY VALUE			
		GROUP 1		GROUP 2	
NO.	SCORE	'TD' BOYS of 1982	'MD' BOYS of 1983	'MD' BOYS of 1982	'MD' BOYS of 1983
1	2	68per cent	89 per cent	86per cent	95 per cent
2	5	38 "	37 "	39 "	35 "
3	4	40 "	60 "	45 "	63 "
4	4	25 "	59 "	45 "	64 "
5	4	14 "	49 "	30 "	55 "
6	5	48 "	30 "	22 "	34 "
7	5	29 "	30 "	28 "	34 "
8	4	35 "	52 "	39 "	51 "
9	5½	15 "	20 "	25 "	28 "
10	4½	6 "	41 "	43 "	43 "
11	4½	6 "	36 "	38 "	37 "
12	2½	37 "	34 "	33 "	36 "
		GROUP 3		GROUP 4	
NO.	SCORE	'TD' GIRLS of 1982	'MD' GIRLS of 1983	'MD' GIRLS of 1982	'MD' GIRLS of 1983
1	2	49per cent	80per cent	86per cent	86 per cent
2	5	29 "	21 "	36 "	37 "
3	4	30 "	45 "	35 "	48 "
4	4	29 "	44 "	27 "	50 "
5	4	14 "	23 "	23 "	31 "
6	5	16 "	16 "	19 "	20 "
7	5	19 "	20 "	22 "	20 "
8	4	34 "	34 "	37 "	39 "
9	5½	9 "	14 "	24 "	22 "
10	4½	7 "	43 "	25 "	44 "
11	4½	7 "	34 "	22 "	36 "
12	2½	20 "	19 "	10 "	30 "

APPENDIX L

Name: ....

School: .... Index Number: ....

THE DEMOCRATIC REPUBLIC OF SUDAN

MIDDLE REGION

The Ministry of Education and Guidance

THE ELEMENTARY CERTIFICATE EXAMINATION MARCH, 1984

SUBJECT: MATHEMATICS TIME: TWO HOURS

DIRECTIONS:

Read these directions before you begin answering the questions:

1. There is only one question paper.
2. Answers should be written on the question paper.
3. You should show all necessary working on the answer paper.
4. Answer all the questions.

QUESTION ONE: Write the correct answer in the empty place:

(1) $6 \times 9 = \square \times 6 = \square$.

(2) 7 + two tens + three hundreds + 5 thousands = $\square$.

(3) $\sqrt{\frac{16}{25}} = \frac{\square}{\square}$

(4) $12 \times 0 + 7 = \square$. (5) $\frac{3}{4} = \square\,\%$.

(6) $\frac{2}{3} = \frac{4}{\square} = \frac{\square}{9}$.

(7) 6.257 metres = ☐ cm approximately.

(8) A prime number is a number which ....

(9) If $\frac{3}{x} = \frac{9}{15}$, then x = ☐.

(10) If the area of a square is $36cm^2$, then the length of one side = ☐.

(11) 6 + 6 + 6 + 6 = ☐ x ☐ = ☐.

(12) The product of the number 9 and the identity element of multiplication = ☐.

QUESTION TWO:

Perform the following calculations:

(1) $2\frac{2}{3} + 1\frac{3}{4} - 2\frac{5}{6}$

(2) $3\frac{1}{2} \times 2\frac{5}{7}$

(3) 1.83 x 0.046

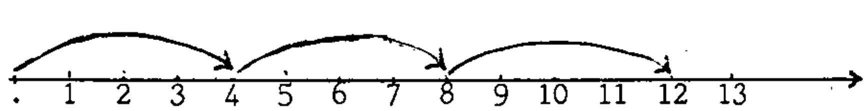
(4) 75.36 ÷ 0.08

(5) $7\frac{2}{5} \div 9\frac{1}{4}$

(6) From the digits 6, 2, 4, form a number which is divisible by 3, 4, 6 together.

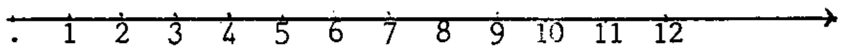
QUESTION THREE:

(1) Write down the operation represented by the number line below.



The operation is ....

(2) Show on the number line the operation 7 + 4 - 5.



Put the appropriate number in the empty place:

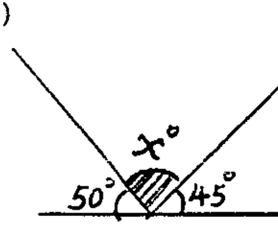
(3) 19 x 7 = 9 x 7 + ☐ x 7 = ☐

(4) If x + 4 + y = 7 + 4 + y = x + 4 + 3, the x = ☐, y = ☐.

QUESTION FOUR:

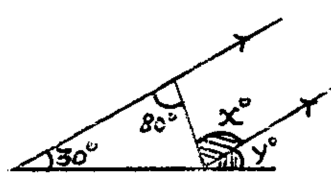
Write down the values of x°, y° in the following shapes:

(1)



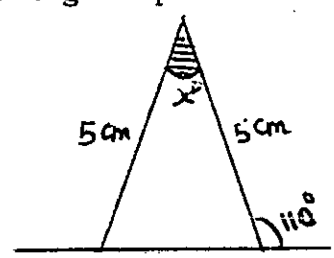
x° =

(2)



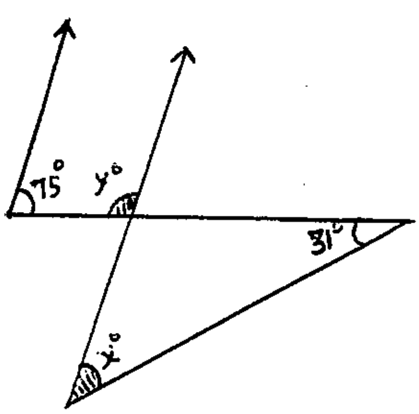
x° =
y° =

(3)



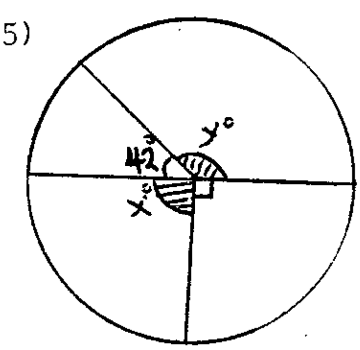
x° =

(4)



x° =
y° =

(5)



x° =
y° =

QUESTION FIVE:

(1) Express the number 1296 in terms of its prime factors, then find the square root of the number.

(2) An electric lamp consumes electricity at the rate of 180 watts every 3 hours. How many watts does it consume in $8\frac{1}{2}$ hours?

(3) A man bought a bag of flour for £65 and he sold it for £78. Calculate his profit percent.

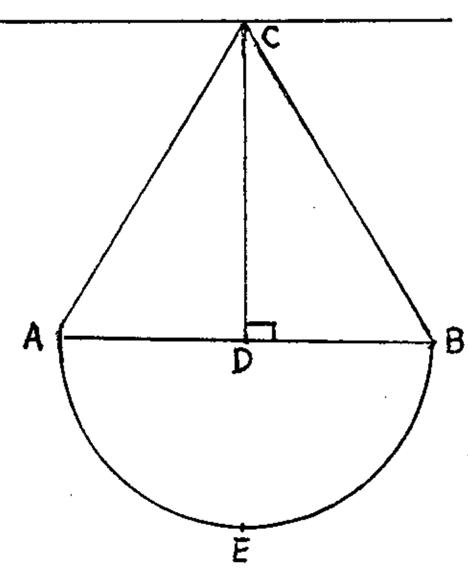
(4) Osman bought a motorcycle for £720 and sold it with a profit of 25%. Calculate his profit and the selling price of the motorcycle.

QUESTION SIX:

(1) The adjacent figure represents an equilateral triangle with a semicircle attached to one of its sides. If the side of the triangle is 7cm, its altitude CD = 6cm and the diameter of the semicircle is AB,

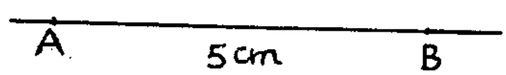
(a) calculate the area of the triangle ABC,

(b) calculate the perimeter of the figure AEBC ($\pi \simeq \frac{22}{7}$).



(2) Draw the parallelogram ABCD in which AB = BC = 5cm, $\angle ABC = 130^\circ$.

Then draw a perpendicular from D on AB to meet AB in E. Measure the length DE, then calculate the area of the parallelogram.



DE = ...

APPENDIX M

Name: ....

School: ....   Index Number: ....

THE DEMOCRATIC REPUBLIC OF SUDAN

MIDDLE REGION

The Ministry of Education and Guidance

THE ELEMENTARY CERTIFICATE EXAMINATION   MARCH, 1983

SUBJECT: MATHEMATICS   TIME: TWO HOURS

DIRECTIONS:

Read these directions before you begin answering the questions:

1. There is only one question paper.
2. Answers should be written on the question paper.
3. You should show all necessary working on the answer paper.
4. Answer all the questions.

QUESTION ONE:

Perform the following calculations:

(a) 0.2×0.04	(b) $5 \div 0.5$	(c) $\frac{2}{3} + \frac{3}{5}$
(d) $4 \div \frac{1}{4}$	(e) $2\frac{1}{2} \times 3\frac{1}{4}$	

QUESTION TWO:

(a) Find the mean of the numbers 5, 7, 9, 11.

(b) Calculate 15% of £20.

(c) There are 1550 inhabitants in a village today. A year ago there were 1500 inhabitants. Find the increase percent of the village inhabitants per year.

(d) Factorise the number 32400, then find the square root.

(e) Jihad, Shatha and Tariq divided £39 between them in the ratio 4 : 4: 5. Find how much each would have.

QUESTION THREE:

(a) Convert $\frac{2}{5}$ into a percentage.

(b) A'isha bought a sewing machine and sold it with a loss of 10%. If she lost £20, what were the selling price and the original price of the machine?

(c) Hasan bought a bed and sold it for £52.50. If his profit was 5% of the original price, find the original price.

QUESTION FOUR:

(a) The price of 5 pounds of sugar is 155 piastres. What is the price of 7 pounds?

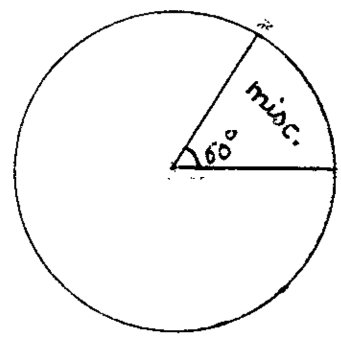
____

____

____

(b) The monthly salary of Ibrahim is £240. He spends it as follows: £80 for house rent, £48 for food, £30 for transport, £30 for medical treatment, £12 for clothing and £40 for miscellaneous expenditure.

Complete the diagram at the right hand side with the given information according to the following order: misc., clothing, medical treatment, transport, food and house rent.



QUESTION FIVE:

(a) Complete the following statements with words that give the correct definition:

(i) A parallelogram is a quadrilateral in which every

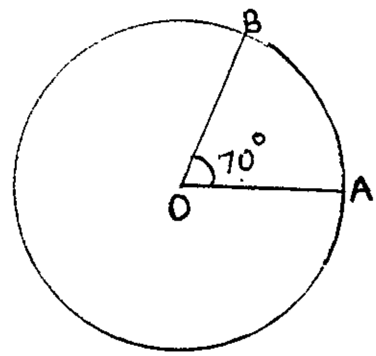
____

(ii) A rhombus is a parallelogram in which

(1) ____________________________

(2) ____________________________

(b) In the diagram at the right hand side, O is the centre of the circle, the radius OA = 6 cm, the angle AOB = 70°.

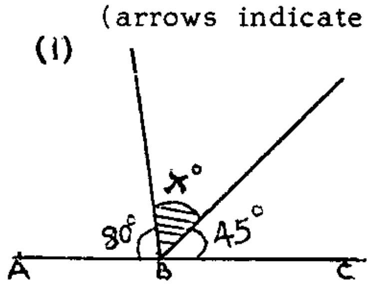


(1) Find the length of the arc AB ($\pi \simeq \frac{22}{7}$).

(2) Find the area of the sector AOB.

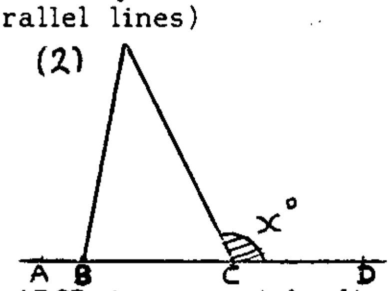
QUESTION SIX:

(a) Find the values of x and y in the following constructions (arrows indicate parallel lines)



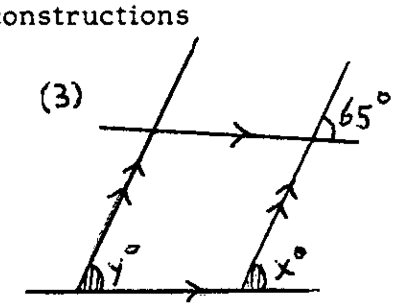
ABC is a straight line

x =



ABCD is a straight line

x =



x =

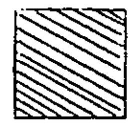
y =

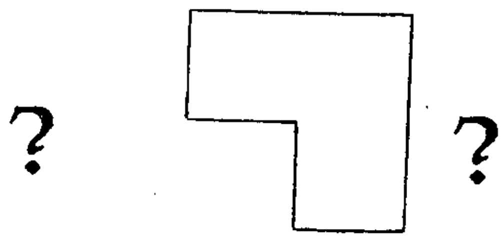
(b) Using a set of compasses and a ruler, draw a parallelogram ABCD in which AB = 5 cm, BC = 6 cm and the diagonal AC = 6.5 cm. From the drawn figure find the length of BD.

APPENDIX N

AREAS 1

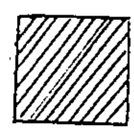
How many squares like this are needed to cover

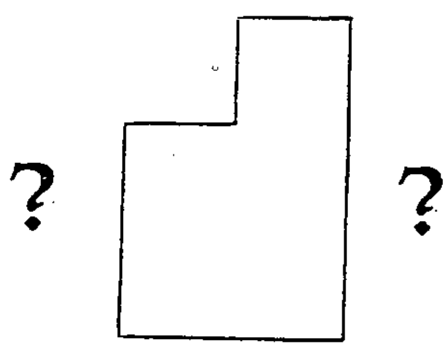




(Lift to check answer)

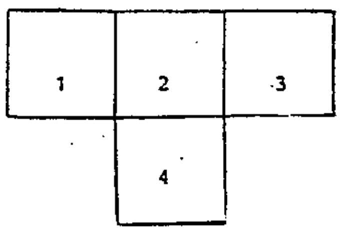
How many squares like this are needed to cover

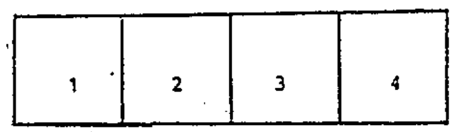




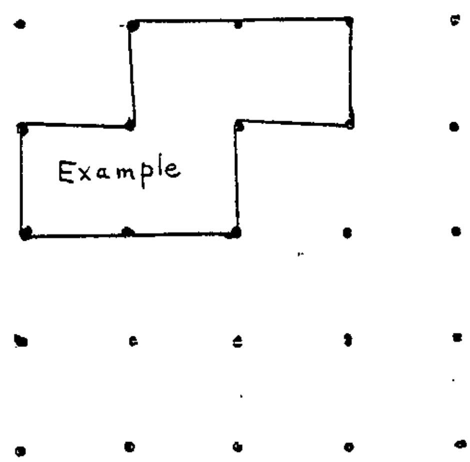
(Lift to check answer)

AREAS 2





Use an elastic band with the board below to find as many shapes with this area as you can



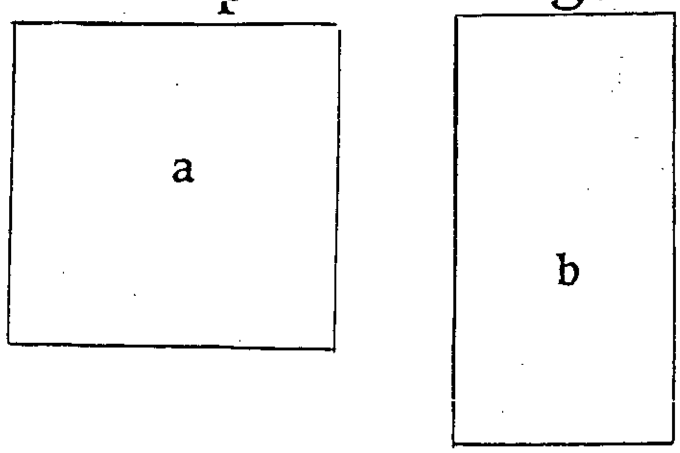
? How many shapes are there with the same area as 4 squares ?

(Lift to check answer)

AREAS 3

Which shape has the greater area

?

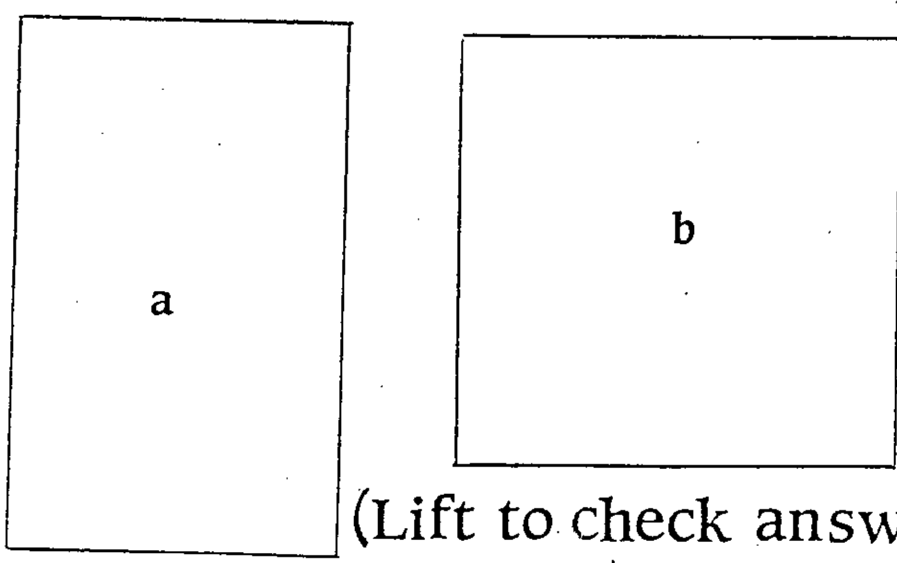


?

(Lift to check answer)

Which shape has the greater area

?



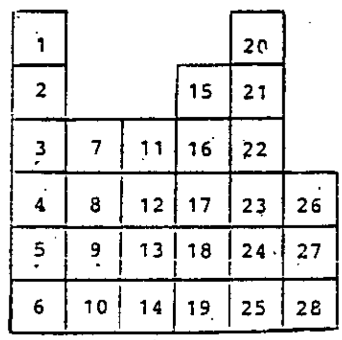
?

(Lift to check answer)

AREAS 4

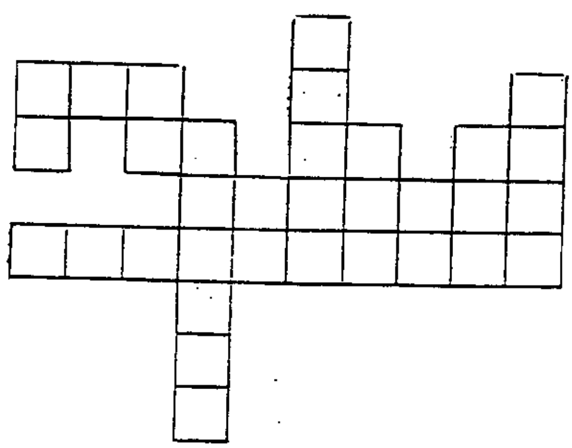
To compare areas a standard square is used. For small areas a square of 1cm is chosen. It is 1 sq.cms.

This shape has area 28 sq.cms.



What is the area of this shape

??



??

(Lift to check answer)

? How many shapes with the area of 5 squares ?

(Lift to check answer)

APPENDIX O

EVALUATION OF THE TEACHING POTENTIAL OF POSTERS FOR THE UNDERSTANDING OF THE BASIC CONCEPTS OF AREA

1. What do you think of the posters?

   (a) good ( ), (b) bad ( ), (c) middling ( ).

   Any comment?

2. Did the children take any notice of the posters?

   (a) some ( ), (b) all ( ), (c) none ( ).

   Any comment?

3. Did you direct the children to look at the posters?

   (a) yes ( ), (b) no ( ).

   Any comment?

4. Did the children discuss the posters between themselves?

   (a) yes ( ), (b) no ( ), or with you? (a) yes ( ), (b) no ( ).

   Any comment?

5. Do you think the posters have helped any of your children? Yes ( ), no ( ).

   (a) some of your children ( )?

   (b) all of your children ( )?

   Any comment?

6. Can you suggest other topics which benefit from this approach?