EXPERIMENTAL STUDY OF PROGRAMMED LEARNING AMONG PRIMARY TEACHER TRAINING COLLEGES IN KENYA

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BY

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This Thesis is my original work and has not been presented for a degree in any other University.

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"This Thesis has been submitted for examination with my approval as University Supervisor".

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The researcher is indebted to Dr. G.S. Eshiwani, her supervisor without whose suggestions and comments at all stages the study could not have been completed. Many thanks as well to Miss E.N. Senvumo for typing the thesis.

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AN ABSTRACT

BY

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Purpose

The purpose of the study was to compare the three methods of presenting programmed materials to the first year students in primary teacher training colleges in Kenya, in their learning of Mathematics. The methods compared were individual programmed learning, programmed learning in pairs, and programmed learning in larger groups.

Rationale

The students in three treatment groups were compared with respect to their achievement, retention change of attitudes towards mathematics and time needed to complete the programme. The null hypotheses stated that there were no differences between the means of students in the three treatment groups with respect to their achievement and retention scores, th no significant change in attitudes towards mathematics taken place after the students have completed the proc ramme and that there were no difference between the means of students in the three treatment groups with respect to the time needed to complete the programme. The hypotheses that the achievement and

retention of students after the completion of the programmed course is independent of their previous academic qualifications were also tested.

The programme used in the study was a linear programme on statistics. The programme was tried out in a pilot study. It contained 180 frames.

Procedures

The sample consisted of three randomly selected primary teacher training colleges. In each college one P1, one P2, and one P3 class were randomly chosen. The ages of students were taken from the colleges' records. No significant differences were found in ages of students in the sample. All the students in the sample classes were pre-tested on the knowledge on statistics, reading ability and mathematical ability. Students who scored 30% or over in the pre-test on statistics were dropped from the sample. The three treatments were randomly assigned to three colleges. The treatments were:

Treatment A: Students went through the programme individually at their own pace, the programme was presented to them in booklet form, one booklet per student.

Treatment B: Students were randomly assigned to pairs. The programme was presented to them in booklet form, one booklet per pair; the two student in a pair were asked to poole their efforts.

Treatment C: Students went through the programme in larger groups (the whole class). The programme was presented to students by overhead projector. Students in the group were asked to poole their efforts.

Students were also administered the questionnaire on attitudes towards mathematics. The same questionnaire was administered to students after the completion of the programme to assess any change in attitudes towards the subject. After the completion of the programme students were administered the post-test on statistics. Ten weeks after the completion of the programme students were administered the retention test.

Findings

The results showed that individual programmed learning produced higher achievement and retention post-test scores than programmed learning in pairs which in turn was more effective in respect to the achievement and retention of students than programmed learning in larger groups. P1 students performed significantly better in post-and retention test than P2 or P3 students. P2 students performed better in achievement and retention post-test than P3 students. No significant change in attitudes towards mathematics has taken place after the completion of the programme. Larger groups and pairs saved on time as compared to individual students.

Implications

The study showed that the achievement and retention of students was affected by the mode of presenting programmed material and by students' previous academic qualifications. The study showed that the individual programmed learning and programmed learning in pairs have an important place in primary teacher training colleges in Kenya, but more research is needed using longer programmes, to assess the optimum size and the structure of the grouped programmed learning before the idea is rejected as the programmed learning in pairs or in groups is less costly and time saving.

CHAPTER 1

1.0 INTRODUCTION

There are almost 3 millions (1,1974) pupils enrolled in primary schools in Kenya and the number is increasing yearly. The rapid increase in enrolment makes it necessary to train more teachers. Kenya's developing economy demands manpower with sound knowledge of mathematics and science. Primary school is supposed to give pupils understanding of basic mathematical concepts and operations, skills to solve the operations and right attitude towards mathematics. This can only be achieved if the quality of mathematics teachers in primary schools is improved. The right place to start would be at primary teacher training colleges. Students entering primary teacher training colleges often have an inadequate mathematical background. Most of them have been taught traditional mathematics and have never heard of topics like Sets, Statistics, Number bases, yet they will be required to teach these topics in primary schools. The duration of the training is 18 months only, out of which more than 3 months are spent on teaching

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[1]UNESCO/UNICEF, Seminar on Basic Education in Eastern Africa, Nairobi, 1974, pp/Ap3/1.

practice. Within this short time a college is supposed to equip a student with a deep understanding of mathematics and methods of teaching the subject. High failure rates in mathematics in primary teacher training colleges leave no doubt about the inadequacy of present methods of teaching the subject, and demand more effective methods to help students to learn the most in a short available time. Well prepared self instructional materials would allow students to learn at their own pace and to study and revise at their own time. This study attempts to evaluate the effectiveness of three methods of presenting programmed materials to students of primary teacher training colleges in Kenya.

1.1 Purpose of the study.

The purpose of the study was to test the effectiveness of three modes of presenting programmed materials to the first year students in primary teacher training colleges in Kenya. Individual programmed learning was compared with programmed learning in pairs and programmed learning in larger groups. The effectiveness of the methods of presenting programmed materials was compared with respect to the achievement and retention of students, time needed to complete the programme and the change of attitudes towards mathematics. Some of the questions intended to be answered in the study were:

1. Which method of presenting programmed material is more effective with respect to the achievement of students?

2. Which method of presenting programmed material is more effective with respect to the retention of students?

3. Which method of presenting programmed material is more effective with respect to the time needed to complete the programme?

4. Do the P1, P2, and P3 students perform equally well in achievement and retention test after the programmed course?

5. Which method of presenting programmed material will produce a more significant change in attitudes towards mathematics?

6. What is the correlation between the scores in reading ability test and achievement post-test?

1.2 Need for the study.

Kenya as most other developing countries is experiencing shortage of qualified teachers. The shortage is felt in every field and it is particularly acute in the field of mathematics and science. Some of the topics in mathematics are poorly taught or skipped as teachers themselves are not familiar with them. Textbooks are inadequate and are as such no great help to a student or a teacher. The change over from traditional to modern mathematics without adequate in-servicing of teachers left many teachers bewildered and unable to cope with the new situation.

Schramm (2, 1964) recommends programmed learning in Africa because of the shortage of teachers, the need for curricula revision which would be brought about by programmed instruction as the construction of programmes demands a close study of teaching objectives

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[2] Schramm, W., Mass Media and National Development, UNESCO, Paris, 1964.

and global knowledge of the subject. This is particularly important for student-teachers. Only when we train better teachers can we hope to achieve better mathematical results in primary schools. The high failure rate in mathematics among primary teacher training students (shown in table 1) since the examination was centralized leaves no doubt about the inadequacy of the present methods of teaching the subject and demands a search for new more effective methods of teaching the subject.

There are great individual differences among primary teacher training students with regard to their previous mathematical background. Some of the students come from well established schools where they were taught mathematics by trained teachers while others come from Harambee schools and have no proper mathematical background. Although the new entry regulations by the Ministry of Education requires a pass in mathematics, this has not yet been fully implemented and even when it will be implemented the differences will still exist.

TABLE 1

PERFORMANCE OF PRIMARY TEACHER TRAINING STUDENTS IN 1976 FINAL MATHEMATICS EXAMINATION.

	P1			P2		
College	P	R	F	P	R	F
Egoji	134	25	3	52	37	17
Asumbi	125	72	11	47	59	56
Eregi	269	83	25	74	29	27
Highridge	41	24	5	23	27	24
Kagumo	138	62	16	35	31	28
Kaimosi	89	50	7	21	34	36
Kamagambo	25	8	3	5	11	21
Kamwenja	86	42	4	46	50	24
Kericho	115	40	16	20	28	22
Kigari	84	18	3	58	37	31
Kilimambogo	73	41	16	43	28	18
Kisii	65	30	5	15	19	14
Machakos	122	41	12	52	28	98
Meru	37	10	1	29	23	11
Mosoriot	98	35	7	41	51	51
Shanzu	103	53	11	32	33	20
Siriba	115	74	11	51	58	51
Thogoto	112	44	11	60	40	29

P = Passed R = Referred F = Failed

Some of the students entering the college did modern mathematical syllabus while oth did traditional one. The result is that mathematics programme in primary teacher training college is too difficult for some students and boring for others. Programme learning will allow each student to progre his or her own pace. Not all the students enter a college at the same time; some com in May while others join in September and may miss some important topics. Those top could be covered by late students by progr learning. As Plummer (3,1967) points out, programmed materials in African countries particularly useful because of the absent and late coming students, because it makes an impact with students who have previousl experienced failure in the subject (which often the case with primary teacher traini students in mathematics), because pupils acquire genuine interest in the subject an are keen to work and because the progress students is more rapid and can be easily c This is particularly important for primary teacher training students as the duration

[3] Programmed Learning in Central African Context University College of Rhodesia, Faculty of Edu Occasional Paper No. 7, edited by D.G. Hawkrid

of the course is two years only. Plummer also recommends programmed learning in African countries as the use of programmed material allows more contact between an individual student and the tutor and for the remedial work and revision. Topics in the programmed form are more thoroughly prepared. Encouraging students to write programmes on the topics they have covered and on the topics they will use for teaching practice will ensure the real understanding of the topic and the teaching objectives, and it will also encourage students to write and use programmed materials in their later teaching. As Roebuck(4,1970) points out: "A massive large scale implementation by government decree might by its sheer size give sufficient support to the individual teacher to use the new materials efficiently. Piecemeal innovations cannot succeed until teacher training prepares teachers to receive the new technique with confidence."

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[4] M. Roebuck: Factors influencing the Success of Programmed Materials in Under-equiped Classrooms and Inadequately Staffed Schools. In Aspects of Educational Technology, Vol. 4. Pitman 1970 pp 97 - 113.

The findings of the study by Lysaught (5,1966) strongly support the idea of introducing programmed material in teacher training colleges. He found out that teachers who were trained and used programmed material in their training make greater use of programmed material in their teaching and have more favourable attitudes to programmed instruction. Theories of learning can be made more directly relevant to the classroom situation and terms like reward, reinforcement, confirmation of the results, conditioning can be illustrated by reference to programmed materials. Lysaught (1966) and Gilbert (6, 1973) suggest that training teachers in techniques of programmed learning will make them better teachers. Hawkridge (7, 1966) suggest that teaching student teachers programmed learning can make a contribution not only by increasing the pool

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[5] Lysaught, J.P., "Inducing Change in the Classroom through the Development of Teacher Programmers", in Aspect of Ed. Techn., Vol. 1, Methuen and Co. Ltd., London, 1966, pp. 399 - 411.

[6] Gilbert, L.A., "Educational Technology in Teacher Education and Training, Prog. Lear. & Educ. Techn., Vol. 10, 1973, pp. 2 - 5.

[7] Hawkridge, D.G., "Programmed Learning and Teacher Education", Teacher Education, 6, 1966, pp. 226 - 231.

of teachers who will be able to construct programmes or who will know how to integrate programmed material into their everyday teaching, but raising also the standard of teaching performance.

1.3 Statement of the problem.

The study investigated three methods of presenting programmed materials to the first year students in primary teacher training colleges in Kenya in their learning of mathematics. The methods compared were individual programmed learning, programmed learning in pairs and programmed learning in larger groups. The programme used was linear programme on statistics. The independent variable in the study was mode of presenting programmed material; individual versus pairs versus larger groups. Dependent variables measured in the study were:

1. A post-test administered after programmed instruction.
2. Time different groups needed to complete the programmed recorded by tutors.

3. Retention of students measured by a retention test identical to the post-test, administered ten weeks after the completion of the programme.

4. Change (if any) in attitudes towards mathematics after students have completed the programmed course measured by two identical questionnaires, one administered prior and the second one after programmed instruction.

Controlled intervening variables were:

1. Previous education background (by taking P1, P2 and P3 classes).

2. Pre-knowledge on subject matter (pre-test on Statistics).

3. Reading ability (reading test).

4. Mathematical ability (Five Dots Test, Working with Numbers Test).

1.4 Hypotheses.

Hypotheses tested in the study are stated below in the null and alternative form.

1. Ho: There is no significant difference between the means of students of the treatments A, B and C with respect to the achievement post test scores. - H_A: There is a significant difference between the means of students of the treatments A, B and C with respect to the achievement post test scores.

2. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the achievement post test scores.
   - H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the achievement post test scores.

3. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment B with respect to the achievement post test scores.
   - H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment B with respect to the achievement post test scores.

4. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the achievement post test scores.

-H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the achievement post test scores.

5. Ho: There is no significant difference between the means of P1 students of the three treatments A, B and C with respect to the achievement post test scores.

- H_A: There is a significant difference between the means of P1 students of the three treatments A, B and C with respect to the achievement post test scores.

6. Ho: There is no significant difference between the means of P2 students of the three treatments A, B and C with respect to the achievement post test scores.

- H_A: There is a significant difference between the means of P2 students of the three treatments A, B and C with respect to the achievement post test scores.

7. Ho: There is no significant difference between the means of P3 students of the three treatments A, B and C with respect to the achievement post test scores.

   - H_A: There is a significant difference between the means of P3 students of the three treatments A, B and C with respect to the achievement post test scores.

8. Ho: There is no significant correlation between the scores in Silent Reading Test and achievement post test.

   - H_A: There is a significant correlation between the scores in Silent Reading Test and achievement post test.

9. Ho: There is no significant correlation between the scores in Five Dots Test and achievement post test.

   - H_A: There is a significant correlation between the scores in Five Dots Test and achievement post test.

10. Ho: There is no significant correlation between the scores of Working with Numbers Test and achievement post test.

    - H_A: There is a significant correlation between the scores of Working with Numbers Test and achievement post test.

11. Ho: There is no significant difference between means of students of the three treatments A, B and C with respect to the time needed to complete the programme.

- H_A: There is a significant difference between the means of students of the three treatments A, B and C with respect to the time needed to complete the programme.

12. Ho: There is no significant difference in attitude towards mathematics prior and after programmed instruction for students of the treatment A.

- H_A: There is a significant difference in attitudes towards mathematics prior and after programmed instruction for students of the treatment A.

13. Ho: There is no significant difference in attitudes towards mathematics prior and after programmed instruction for students of the treatment B.

- H_A: There is a significant difference in attitudes towards mathematics prior and after programmed instruction for students of the treatment B.

14. Ho: There is no significant difference in attitudes towards mathematics prior and after programmed instruction for students of the treatment C.

- H_A: There is a significant difference in attitudes towards mathematics prior and after programmed instruction for students of the treatment C.

15. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the retention test scores.

- H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the retention test scores.

16. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment B with respect to the retention test scores.

- H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment B with respect to the retention test scores.

17. Ho: There is no significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the retention test scores.

-H_A: There is a significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the retention test scores.

18. Ho: There is no significant difference between the means of P1 students of the three treatments A, B and C with respect to the retention test scores.

-H_A: There is a significant difference between the means of P1 students of the three treatments A, B and C with respect to the retention test scores.

19. Ho: There is no significant difference between the means of P2 students of the three treatments A, B and C with respect to the retention test scores.

-H_A: There is a significant difference between the means of P2 students of the three treatments A, B and C with respect to the retention test scores.

20. Ho: There is no significant difference between the means of P3 students of the three treatments A, B and C with respect to the retention test scores.

- H_A: There is a significant difference between the means of P3 students of the three treatments A, B and C with respect to the retention test scores.

1.5 <u>Description of the materials used in the experiment.</u>

The programme used was adopted from R.A.Konchla: Statistics, a Unit for Introductory Psychology.

Title of programme: Statistics for Teachers.

Level: First year primary teacher training colleges.

Form: Linear programme in booklet form with answers appearing on left-hand of the succeeding page. The text is typescript.

Length: Each booklet has ten pages, each page contains one frame, each frame requires one or two responses.

Criterion behaviour: After the completion of the programme the students should be able to:

1. Define statistical terms such as variable, constant, frequency, measurement, table, graph, mode, median, range, deviation, data, possible values ....

2. Arrange raw dats in tables.

3. Represent data graphically.

4. Calculate the measures of central tendency and dispersion from a set of given data.

5. Arrange data in grouped frequency tables.

6. Apply statistical procedures to the classroom situation, compare two sets of data, read graphs and make predictions.

Silent Reading Test was adapted from Schonnel, F.J.: Diagnostic and Attainment Testing, Silent Reading Test B.

Five Dots Test and Working with Numbers Test were used in their original form.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Historical background of programmed learning.

The theoretical foundations of programmed learning are based on psychology of B.F. Skinner (8, 1960) Programmed instruction is not only another teaching technique, but it incorporates the practical application of laws of learning established by scientific method.

In order to understand Skinner's work it is necessary to refer to the experiments of Pavlov. In this experiment the hungry dog is given a meat ball. When this happens he produces saliva. A mere sight of food suffices the secretion of saliva. This is a primary reflex. At the second stage the secretion of saliva is associated with ringing of the bell. A bell is finally rang without producing food and the saliva is secreted. A conditioned reflex has now been set up. Pavlov

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8 Skinner, B.F., "The Science of Learning and the Art of Teaching", in Teaching Machines and Programmed Learning, Department of Audio Visual Inst., National Ed. Ass., 1960, Washington, pp 99 - 114.

excluded from his experiments all but the factors under observation. He interpreted his results with reference to neurological mechanism. From his experiments he built up his theory of the system of reflexes, from the simplest to the most complicated as that of language. He established rules of a training system which was later called 'conditioning.'

Thorndike followed Pavlov's ideas, but he refused to explain psychological facts by physiology only. He studied animals' learning and he observed that the best way to fix responses is by connecting them with the satisfaction of the need. He also concluded that animals learn by trial and error.

Watson attached great importance to conditioned reflexes set up by Pavlov. He disagreed with Pavlov's interpretation of results in terms of the nervous system only as it cannot be verified. He proposed that a scientist should confine himself to what can be controlled and observed, that is stimulus and response. What lies between the two, we know nothing about, it is so-called 'black box', a hypothesis which cannot be verified. Watson experimented with rats and mazes. A rat had to pass from the point of entry to the exit, having to choose one of the several possible routes at various points. If a rat went wrong it received a mild electrical shock. When a rat reached the exit it received the reward. The behaviour of the animal is characterised by trial and error. From his experiments Watson deduced his laws of behaviour. Those are: law of recency, practice or exercise and effect. The response is more firmly fixed if more often repeated (practice), the last response will be repeated as it is the most recent one (proximity), the correct response is more readily repeated (effect). From his experiments Watson deduces his theory of learning and teaching. He states: (9, 1972)

"Give me a dozen healthy infants well formed, and my own specific world to bring them up in, and I will guarantee to take any one of them at random and train him to become any type of specialist I might select .... regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors."

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[9] Docstar, J., The Theory and Practice of Programmed Instruction, UNESCO, Paris, 1972, pp 34.

The modest contribution of American psychologist Pressey was also important. He constructed a small apparatus, a testing machine. He applied to it the laws of behaviour. The machine gave students a set of questions, to be replied to by selecting one of the several possible answers. The student could not go to the next question until he has found the correct answer. In that way the machine not only served as a testing device but also as a teaching device. The machine put into practice the three laws of behaviour, the law of recency as the correct answer is the most recent one, the last chosen, the law of practice, the correct answer being the most frequent one since it allows student to proceed to the next question, and the law of effect since the progress could only be made by choosing the correct answer.

In 1938, Miller and Komorsky[10] found out while experimenting with animals that when an animal received a reward for the performed action, it was likely to repeat it. Even if the original action was not performed by a stimulus but was spontaneous, the reward was a stimulus for the new action.

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[10] In Pocstar, J. The Theory and Practice of Programmed Instruction, Unesco, Paris, 1972, pp 36.

The originator of programmed learning is American psychologist B.F. Skinner. He experimented with pigeons, teaching them among other things, to differentiate between horizontal and vertical stripes, which was not possible in the experimental conditions set out by Pavlov. It could then be concluded that pigeons do not possess the physiological capacities to distinguish vertical and horizontal lines. Skinner placed the pigeons in his own experimental environment, allowing them to do what they liked, placing a red and a green circle in the cage. When a pigeon on his own pecked at the red circle, he is awarded. The reward is given any time the pigeon pecks at the red circle. The pigeon will finally peck at the red circle without any reward. Red cirlce is replaced by horizontal lines gradually and the green one by vertical ones. The pigeon goes on pecking on the vertical lines even when the colour has disappeared and only the lines are left.

Skinner's experiments are basically different from Pavlov's. Skinner does not isolate the factor to be studied. The selection of the factor is left to the animal which through its own activities build up the learning process. The desired actions are rewarded so as to induce the animal to adopt a certain mode of behaviour. The reward has become a stimulus for the new action. There are no negative stimuli used in the experiment. The pigeon progresses step by step without being punished for his errors. Stimulus comes after the action and it operates retrospectively, reinforcing the action already performed. The law of behaviour should now be understood in this light. Animals learn by being active and the same applies to men.

Principles of programmed learning

1. Step by step principle. Effectiveness of learning depends on the frequency of reinforcement. The maximum number of reinforcements can be achieved by dividing the subject matter to be learned into small units each requiring the response. Progress is made step by step. The confirmation of the correct answer is the reinforcement.

2. Activity. Pupils must actively participate in the learning process by doing the exercises to assimilate the subject matter to be learned.

3. Success. Errors and failures must be avoided. Pupils will learn much faster if they see that they are succeeding.

4. Immediate verification of the results. A pupil must know before going to the next step if his action was correct.

5. Logical progress of learning. The material to be taught should be logically organised, activities should centre on the information to be taught. All the superfluous elements should be eliminated.

6. The principle of individual pacing. Pupils should be left to learn at their own pace.

<u>Types or models of programmes.</u> Linear programmes are composed of a number of parts called frames. Each frame requires a response from a pupil. Each frame is clearly separated from the other. The frames are usually numbered and studied in a numerical order. When a pupil has gone through the frame and given the response, he checks his answer. Frames should be as short as possible in order to avoid error. Each frame constitute a stage of progress. The required response refers to the actual frame. The response should ensure active participation of a pupil. Skinner demands that his programmes should be 95% successful.

Crowder's programme. Pupils are directed to the various parts of the programme according to the responses they make. Frames are larger and the responses are given in a multiple choice form. Skip-branching programmes allow students to skip some parts of the programme or a loop route for students who have not understood some items in the programme.

Programmed learning in Africa.

Programmed learning is a comparatively an unknown field in Africa. Lawless (11,1969) calls for the need to revalidate programmes produced outside Africa. He carried out his research in secondary schools in Malawi using programmes in Biology. He compared multiple-choice and constructed responses across four categories of learning, verbal association, generalisation, multiple discrimination and chaining. No significant

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[11] Lawless, C.J., "Programmed Learning in Developing Countries of Africa." Prog. Lear. and Ed. Tech., 1969, 16 , pp. 189 - 196.

difference was found with respect to the achievement and retention scores. Pupils who used multiple-choice version of programmes took considerably less time to complete the programme. Calder and Raab (12, 1970) stress the potential uses of programmed learning in upgrading the skills of teachers (such experiments were done in Algeria), changing attitudes of teachers and students towards the subject, guiding practical work (Roebuck used programmed material in practical Biology in Nigeria and Bunyard used it in the same country for practical Physics), and for vocational and technical education. Hawkridge (13, 1967) calls for more permanent resource centres in developing countries to provide the material, information and encouragement to teachers using programmed material. He also points out the difficulty arising from the fact that students in developing countries have to use the programmes in their second languages.

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[12] Calder, J.R., and Raab, C.N., "Problems of Teaching in Developing Countries", Programmed Learning Bulletin, No. 1, August, 1970.

[13] Hawkbridge, D.G., "Evidence from Programmed Learning Research in Central Africa", National Society for Programmed Instruction, 8, pp 10 - 15.

Plummer (14,1967) experimented with programmed material in Rhodesian schools. His programmes have proved successful with most students. He observed that the programmes appear to make an impact with pupils who have previously experienced failure in the subject. Pupils were more keen to work with programmed material. The progress was more rapid. He also recommends programmed learning for African countries because of large classes. Programmed learning allows more individual contact between a teacher and pupils, pupils' progress can be easily checked, it will releve teachers of monotonous and repetitive marking and it will allow the absent students to catch up with the subject matter. He recommends programmed learning for remedial work. He points out that teachers will learn a great deal from preparation of the programme.

Hartley (15, 1964) reports on the progress of UNESCO set up workshop on programmed learning in 1962 in Ibadan. He calls for more in-service teacher training courses on programmed instruction.

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[14] In Programmed Learning in Central African Contexts. University College of Rhodesia, Faculty of Education Occasional Paper No. 7, edited by D.G. Hawbridge.

[15] Hartley, J. "Programmed Learning in Emerging Nations." Programmed Learning, 1964, 1, pp. 21 - 25.

Programmed instruction is used in some African universities (Zambia, Lesotho, Malawi). A study of programmed learning was carried out in the Department of Educational Psychology at Makerere University. No significant difference was found between programmed instruction and conventional teaching. Some experiments were done in Ghana and Central Africa. In the opening address for the conference on Programmed Learning and Research in Adult Education in Nairobi 1966, Mr. Mwendwa recommended programmed learning for African countries because (16,1966) "step by step the student is guided forward, from the basic elements of his subject towards its more advanced and complex stages. At every point there is a built-in check on his real grasp of the material so far preserved. At the same time, the method imposes a valuable discipline on the teacher using the course in the classroom. He

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[16] Programmed Learning and Research in Adult Education Conference Proceedings 1966, Adult Association of East and Central Africa, Mr. Mwendwa's opening address, pp. 15.

is forced to view the object as a continuous related whole and at the same time to break it down into its smaller component units of knowledge; and he has a continuous built-in check on the progress of his students."

Schramm (17,1964) recommends programmed instruction for African countries because of the shortage of teachers, the need for curriculum revision which could be brought about by programmed instruction as the construction of programmes demands a clear understanding of teaching objectives and the logical organisation of the material to be learned. Programmed instruction will allow every student to progress at his fastest pace. He calls for more research on sequence, step, error rate, mode of response in programmed learning in African countries.

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[17] Schramm, W., Mass Media and National Development, UNESCO, Paris, 1964.

Roebuck (18, 1970) reports on some of the findings of experiments in programmed instruction in Nigeria. "During 1967 and 1968 programmed materials of commercial origin and some specially produced by Nigerian Researchers were used with over 2000 secondary school pupils in West Nigeria in a wide variety of schools and under a range of conditions. Experiments to compare conventional teaching and programmed learning were avoided. Attempts were made to use programmes as widely as possible and therefore to identify those factors influencing the success of the programme in typical school environment. Systematic variations of the form of presentation and types of programming were assessed. Some of those variations attempted to investigate problems related to acculturation and the use of programmes in the second language. Attainment of pupils varied greatly and was found less dependent on the structure of the programme or

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[18] Roebuck, M., "Factors influencing the Success of programmed Materials in under-equiped classrooms and inadequately staff Schools." Aspects of Educational Technology, Vol. 4, pp. 97.

its form of presentation than upon administrative and background factors operating in the school system. Many teachers found programmes administratively difficult. There was a conflict between the needs for individual instruction and the traditional role of teacher. All the programmes produced significant amount of learning. Pupils were found to have more favourable attitudes to programmed instruction than to conventional teaching. Pupils' attainment were heavily dependent upon home and background factors and pupils' attitudes reflected language and administrative characteristics of the school.

It is suggested that currently available self-instructional materials will not work where they are most needed and that the factors identified by the project in a developing country are basically similar to those influencing innovations in British classrooms, though the solutions must be different." He goes on describing some of the difficulties encountered while experimenting with programmed materials in Nigeria due to the often transfers of teachers who co-operated in the project and absenteeism of pupils due to the unpaid school fees.

He reports that African pupils found it more difficult to respond by filling in blanks left in sentences than by answering straight questions.

Bunyard (19, 1972) used a programme in General Science to compare Nigerian and English children's attainment in programmed instruction. His result shows that programmes written for English children are not very effective for Nigerian children.

Programmed learning in groups.

Programmed learning was originally meant for individuals to work at their own pace. It has been suggested that programmed learning in groups could be just as effective as individual programmed learning. Amaria et al (20, 1969) concluded that the notion that programmed learning is an individualised process can be abolished. Group programmed learning is at least as effective as individual

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[19] Bunyard, J., "A Comparison of the Learning Achieved by Nigerian and English children from Programmed Material", Programmed Learning and Ed. Technology, 1972, No. 9, pp. 25 - 29.

[20] Amaria, R., Biran, L.A., Leith, G.O.M., "Learning in Pairs", Research Notes on Prog. Learning, 10, National Centre for Prog. Learning, University of Birmingham.

programmed learning and takes no longer. They compared individual programmed learning with programmed learning in homogenous, heterogeneous and random pairs. Group programmed learning had better results with lower ability students at primary and secondary level.

Williams (21, 1963) argues that one disadvantage of individual programmed learning is the loss of communication skills by students. He suggests that groups of pupils could be organised in groups when learning by programmes provided the optimum pacing rate is achieved. In that case programmed learning in groups could offer considerable advantages. The cost of production of programmed materials will be reduced and the students will have the opportunity for social interaction and discussion.

Dick (22, 1963) found out that the retention of the students who went through the programme in pairs was better after one year than of the students who went through the programme individually.

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[21] Williams, J.P., "Comparison of several response models in a review programme." Journal of Educ. Psychology, 54, pp. 253 - 260.

[22] Dick, W., "Retention as a function of paired and individual use of programmed instruction", Journal of Programmed Instruction, 2, No. 3, pp. 17 - 23.

His significant level was 0.07. The paired students took considerably longer to complete the programme.

Hartley and Hagarth (23, 1973) concluded that programmed instruction in pairs could be just as effective as individual programmed instruction. They suggest that using pairs instead of individual students will present a more economical use of programmed material.

Austwick (24, 1965) used individual students, matched and random pairs and compared their attainment and time needed to complete the programme. Paired students took significantly shorter time.

Sawiris (25, 1966) used a sample of 124 boys and girls with a linear geometric programme. He

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[23] Hartley, J. and Hagarth, W.F., "Mixed Ability versus own choice Pairs", Prog. Learning and Educ. Technology, 1973, No. 10.

[24] Austwick, K. "Research Report" New Education, 1, No. 1, pp. 25 - 26.

[25] Sawiris, M.Y., "An Experimental Study of Individual and group Learning Using a Linear Geometric Programme", Programmed Learning, 3, 1966, pp. 146 - 153.

compared individual programmed learning versus programmed learning in homogenous pairs versus programmed learning in heterogeneous pairs versus programmed learning in homogenous groups of eight, versus programmed learning in heterogeneous groups of eight versus programmed learning in heterogeneous group of sixteen. Group of sixteen was presented programmed material by overhead projector. Pupils who worked in groups were asked to poole their efforts. Test showed that homogeneous pairs performed better than group of sixteen or groups of eight. No significant difference was found in performance of individual students and students who worked in pairs. Performance of students in groups seemed to decrease with the size of the group.

Noble (26, 1967) compared three groups of children matched on four variables. Members of two of the groups were allowed to work together whilst the members of the third group went through the programme individually. No significant difference was found with respect to the post-test scores but a more detailed examination of the results showed that paired groups have performed significantly

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[26] Noble, G., in Aspect of Educ. Technology, III, Pitman, London, 1969, pp. 78 - 85.

worse when answering the more difficult questions than students who worked through the programme on their own.

Holroyd et al (27, 1970) found that group paced presentation of tape/slide programmes was just as effective as self-paced presentation. Subjects of the study were fourth year medical students. Students were found to have less favourable attitudes to group presentation than to individual presentation.

Hartley (28, 1967) compared programmed learning in homogeneous pairs with programmed learning in heterogenous pairs. He stresses that there is considerable evidence of superiority of grouped programmed learning as compared to individual programmed learning.

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[27] Holroyd, C., Lever, R., Kennedy, H., Dunn, W.R., and Harden, R. "Programmed Instruction - Individual and grouped Presentation of Audio Visual Programmes", In Aspects of Educ. Technology, 4, Pitman, London, 1970, pp. 409 - 415.

[28] Hartley, J., and Cook, A., "Programmed Learning in Pairs: the Results of Miniature Experiments", Prog. Learning and Educ. Technology, 1967, 4, pp. 168 - 172.

Leedman (29, 1964) used ninety children in eight schools and linear instructional programme designed for revision in small groups. Some pupils revised with the teacher and others with the programme in groups of eight. The findings of the study show that there is some justification for such group revision programmes as students revising by the group programmed learning performed just as well as the ones revising with a teacher.

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[29] Leedman, J., "Using Linear Programme for Revision", Prog. Learning, 1964, 1 , pp. 26 - 30.

CHAPTER 3

3.0 PROCEDURES

The principals of the three primary teacher training colleges in the sample were visited and the aim of the study was explained to them. After the author secured their permission and co-operation he selected randomly the three sample classes in each college. The head of Mathematics-Science department and the tutors involved were explained the aim of the study and the principles of programmed learning. The tutors involved in the study went through the programme together with the author. Students in the sample classes were then administered the pre-test on statistics. After the pre-test was marked eight P1 students, seven P2 students and no P3 students were dropped from the sample at Mosoriot Teacher Training College as they scored 30% or over in the pre-test on statistics. In the other two teacher training colleges the students that dropped were six P1, six P2 and four P3 students in one college and eleven P1, six P2 and four P3 students in the other college. The number of students who remained in the sample was 183. Ages of students were found from college records. Students were then administered Silent Reading Test, Five Dots Test, Working with Numbers Test and The Attitudes towards Mathematics Questionnaire. The pre-tests were administered to students during their regular mathematics lessons by their tutors. After students finished the pre-tests they went through the programme under their respective treatment groups. Two days after the completion of the programme students were administered the post test on statistics and the Attitudes towards Mathematics Questionnaire. Ten weeks after the completion of the programme students were administered the retention test.

The programme was carried out without any special difficulties and without absentees. The tutors were five men and one woman. Out of the six tutors three were graduates and three were S1. Because of the administrative difficulties all the students under the treatment A and B went through the programme but only the ones in the sample sat for the pre-tests and post tests. Under the treatment C only the students in the sample went through the programme so as not to make the groups too large. When a student or a pair finished the programme the tutor recorded the time the student or the pair needed to complete the programme (in hours). Students in pairs could sit anywhere they chose. After the lesson was over all the students returned the booklets. The responses to the frames could be either written or oral and were not checked. Tutors reported that students enjoyed working with the programme. In group C the overhead projector was operated by the tutor. The frame was changed when the students so desired. Students sat in the semi-circle around the overhead projector. According to tutors' reports not all the students participated in the discussions and the pace seemed to be determined by the active students in each group. All the three groups under the treatment C had the same tutor.

3.1 Pilot Study.

The pilot study was carried out with the P3 class at Thogoto Teacher Training College. The college was randomly selected out of the three colleges near Nairobi (Highridge, Thogoto and Machakos). It was not possible to randomly select one college out of the total population of 17 primary teacher training colleges in Kenya due to the financial difficulties arising from the fact that it was necessary to travel to the college daily for two weeks while trying out the programme. The programme was tried out by overhead projector. After each frame the students gave opinion about the frame and the frames which students found confusing or failed to get the right response were corrected. The P3 class was chosen as it had the lowest educational background in the population. The P3 class was selected randomly out of the existing P3 classes in the college. All the students in the class participated in the programme. The trying out of the programme lasted two weeks and was carried out due to the administrative difficulties after regular classes daily from 5.00 p.m. to 6.00 p.m. The programme was tried out in November and the regular classes could not be interrupted as the students were revising for end of the term tests. The try out was supervised by the writer.

The actual pilot study was carried out in February 1977. The reasons for pilot study were to find out how successful was the revised programme and to find out if tests used in the main study were reliable, valid and if the time given for the test was sufficient, if the language used in tests was understood and if the items were not too difficult.

Population for the study were 17 primary teacher training colleges in Kenya. The writer first of all randomly selected three provinces. In the second stage one college was randomly selected in each province. In the third stage one college out of the three selected in the second stage was randomly selected for the pilot study. In the fourth stage a P3 class was randomly selected out of the existing P3 classes in the selected college. The P3 students were chosen as they had the lowest educational background in the population and the writer reasoned that if the programme and the tests were not too difficult for them the same would apply for P1 and P2 students who had two more years of formal education than P3 students.

Students in the pilot study were first pretested on the knowledge of statistics.

The test was then marked and only students who scored under 30% participated in the programme. Five students were dropped and twenty one remained in the sample. The twenty one students were then administered Silent Reading Test, Working with Numbers Test and Five Dots Test. An additional student was dropped out of the sample later due to the illness. Twenty students went through the programme individually. The programme was administered to them in booklet form, one booklet per student. The supervision of the programme and the tests was done by the regular mathematics tutor in the college, that was the class mathematics tutor. The tutor was a man of about 30 years of age who later participated in the main study. The principles of programmed learning were explained to him and he went through the programme with the writer. The booklets were handed out by the tutor but the system was not satisfactory due to the delays caused by the fact that several students would finish the booklet at the same time and would crowd up at the tutor's desk for the new booklet.

It was therefore decided for the main study that the booklets would be kept on the separate desk, arranged in numbers and students were to collect them on their own. The tutor was asked to supervise the programme only, not to help students. The basic principles of programmed learning were explained to students by the tutor. Students were aware that they were participating in an experiment.

The main aim of the pilot study was to find out if the tests were valid and reliable. Tests were validated against students' mathematics grades at E.A.C.E. or K.J.S.E. combined with tutor's assessment of students' performance in mathematics in the previous academic term (Pre-test, post-test, Five Dots Test, Working with Numbers Test) and against students' grades in English at E.A.C.E. or K.J.S.E. combined with tutor's assessment of the student's performance in English in the previous academic term (Silent Reading Test.) Item analysis was carried out for all the tests (see the appendix C)* and it showed that the time given for the Five Dots Test and Working with Numbers Test was too short. The time for both tests

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* Appendix C page 208

was therefore extended in main study by five minutes. Reliability coefficients were calculated for the tests and are given in Table 3. Means and standard deviations for the tests are given in Table 2. All the tests were administered twice in the interval of seven days and the reliability coefficients were calculated by Kuder-Richardson method. All the figures in the tables are approximated to two decimal places.

EXPERIMENTAL DESIGN.

3.2 Sample and experimental design.

Population consisted of seventeen primary teacher training colleges' first year students in Kenya. Table 4 shows the population of the study. Population was composed of 24 so called P1 classes with 678 students and 47 P2 classes with 1302 students. With the new directives of the Ministry of Education the P1 and the P2 classes compose a general class and the grade of a teacher will be decided on the strength of the performance in the final examination at the teacher training colleges. As the colleges still had the former P1 classes separated from the former P2 classes by the time the study

TABLE 2

MEANS AND STANDARD DEVIATION FOR THE TESTS

Test	Mean	Standard Deviation
Pre-test	11.38	8.93
Post-test	72.60	13.02
Silent Reading Test	26.19	6.43
Five Dots Test	7.19	5.83
W.w.N. Test	5.19	2.44

TABLE 3

CALCULATED RELIABILITY COEFFICIENTS.

Test	Reliability Coeff-icient
Pre-test	0.93
Post-test	0.79
Silent Reading Test	0.91
Five Dots Test	0.82
Working with Numbers Test	0.84

TABLE 4

THE POPULATION IN 17 PRIMARY TEACHER TRAINING COLLEGES FIRST YEAR STUDENTS IN KENYA

College	P1		P2		P3		Total	
	C	N	C	N	C	N	C	N
Asumbi	2	50	3	75	4	100	9	225
Egoji	1	25	3	75	4	100	8	200
Eregi	2	70	3	108	6	147	11	325
Highridge	1	33	1	34	2	63	4	130
Kagumo	1	30	3	90	4	120	8	240
Kamwenja	2	50	3	75	4	100	9	225
Kaimosi	1	25	3	75	4	100	8	200
Kericho	2	60	3	90	6	180	11	330
Kigari	1	30	2	60	3	90	6	180
Kilimambogo	1	30	2	60	3	90	6	180
Kisii	1	25	2	50	3	75	6	160
Machakos	1	30	3	90	5	150	9	270
Meru	1	24	1	25	2	50	4	99
Mosoriot	1	40	3	80	5	108	9	228
Thogoto	1	30	3	90	5	150	9	270
Siriba	3	75	6	150	8	200	17	425
Shanzu	2	51	3	75	4	100	9	226
Total	24	678	47	1302	72	1933	143	3913

C = Number of classes

N = Number of students

was carried out, the same division was used for the sample. The P1 students were the ones who got division 1 or 2 at the E.A.C.E. and P2 students were the ones with division 3 at the E.A.C.E. The population included 72 P3 classes with 1933 students. The P3 students are the ones who got the division 4 at the E.A.C.E. or have passed K.J.S.E.

A simple random sample of three provinces was drawn first. These were Nairobi, Central and Rift Valley Provinces. One college was drawn from each province by a simple random draw. The three colleges selected were Highridge, Mosoriot and Kilimambogo. In each college one P1, one P2 and one P3 class were randomly drawn. Each college was randomly assigned to one of the three treatments. The mathematical background of the students in the sample varied, but with the exception of the P1 students, majority did not pass mathematics in their last public examination. The ages of students in the sample were taken from the college register and varied from 19 to 30. Table 5 shows the mean ages of students in each group and standard deviation for ages of students in

TABLE 5

MEAN AGES AND STANDARD DEVIATIONS

College	Mean	Standard Deviation
Mosoriot P1	23.29	2.48
Mosoriot P2	22.83	1.77
Mosoriot P3	22.84	2.29
Kilimambogo P1	23.00	2.21
Kilimambogo P2	23.36	2.20
Kilimambogo P3	23.50	2.80
Highridge P1	22.71	1.24
Highridge P2	22.65	2.31
Highridge P3	22.55	2.11

each group. There was no significant difference in ages between P1, P2 and P3 students at Mosoriot Teacher Training College (F = 0.25; 2,57 d.f.). There was no significant difference in ages between P1, P2 and P3 students at Kilimambogo Teacher Training College (F = 0.10; 2,66 d.f.). There was no significant difference in ages between P1, P2 and P3 students at Highridge Teacher Training College (F= 2.11; 2,51 d.f.). Table 7 shows the number of students of each treatment group in the sample.

3.3 Pre-tests.

Students were pretested on knowledge on statistics. The pre-test on statistics lasted sixty minutes and had two parts. Part A was composed of ten multiple choice questions testing knowledge and application. Part B was composed of eight essay type questions testing application and comprehension. Each correct item in Part B scored ten marks and each correct response in part A scored 2 marks. The whole test was marked out of 100. The pre-test on statistics was combined by the author and was tried out in the pilot study.

TABLE 6

MEAN AGES FOR THE STUDENTS OF THE THREE COLLEGES IN THE SAMPLE

College	Mean
Mosoriot	22.99
Kilimambogo	23.25
Highridge	22.64

TABLE 7

THE NUMBER OF STUDENTS IN EACH GROUP IN THE SAMPLE

Students	Treatment A	Treatment B	Treatment C	Total
P1	17	20	14	51
P2	18	25	20	63
P3	25	24	20	69
Total	60	69	54	183

Silent Reading Test was composed of 15 items. Each correct response scored one mark. Each question required two or three responses. The whole test was marked out of 32. The test was adapted from Schonnell's Diagnostic and Attainment Testing, Silent Reading Test B. The duration of the test was 15 minutes in the pilot study and 20 minutes in the actual study. The time for the test was extended in the main study as many students could not finish the test in the pilot study.

Working with Numbers Test was administered in the original form and had twelve questions. Each correct item scored one mark. The test was marked out of 12. The time for the test was extended by five minutes in the main study for the same reasons as for the Silent Reading Test (to 25 minutes).

Five Dots Test was marked out of 18, one mark for each correct answer. The duration of the test was extended from 15 minutes in the pilot study to 20 minutes in the main study.

The pre-test on the Attitudes towards Mathematics had twenty items. In each item there were four possible responses; strongly agree (+2), agree (+1), disagree (-1), and strongly disagree (-2). There were ten negative statements about mathematics in the questionnaire and ten positive ones.

3.4 Treatments.

Three methods of presenting programmed material were tested. The three treatments were randomly assigned to three colleges. The programme was presented in a booklet form or by overhead projector. The whole programme consisted of 18 booklets. Each booklet contained ten frames. Each frame was on a separate page and the response was written on the left top side of the succeeding page. Frames were numbered. On the overhead projector one frame was projected at a time followed by the response. In the study, three treatments are named for convenience sake with capital letters A, B and C.

Treatment A

Students went through the programme individually at their own pace. Each student had his or her own booklet. Booklets were kept on the desk and students collected them themselves. When a student finished with a booklet he returned it and collected a new one.

Treatment B

Students went through the programme in pairs. Students were randomly assigned to pairs. The programme was presented in booklet form, one booklet per pair. The two students in a pair went through the programme at their own pace. When a pair finished the booklet any of the two students could return the booklet and collect a new one. Discussion between two students in a pair was allowed.

Treatment C

Students went through the programme in larger group, the whole class. The programme was presented by overhead projector. The pace of learning was decided by the group. The discussion among the students in a group was allowed. Students were asked to pool their efforts. The overhead projector was operated by the tutor.

3.5 Post-tests.

The post test on statistics was administered to students two days after the completion of the programme. It lasted 60 minutes. It had two parts, part A testing knowledge and application and part B testing comprehension and application. Part A was composed of ten multiple choice items, each scoring two marks. Part B had eight essay type questions, each scoring ten marks. The whole post-test was marked of 100.

The retention test was administered ten weeks after the post test and was identical in content and scoring to the post test.

Post test on attitudes towards mathematics was identical to the pre-test on attitudes towards mathematics and was scored in the same way.

3.6 Treatment of data.

1. Means and standard deviations were calculated for all the pre-tests and post-tests.
2. Means and standard deviations were calculated for ages of students in all the groups. ANOVA was used to find if there were any significant differences in ages.

3. Differences between the mean scores of the treatment groups in the pre test on statistics were calculated by ANOVA.

4. Differences between the mean scores of P1, P2, and P3 students in each treatment group in the pre-test on statistics were calculated by the ANOVA.

5. Differences between the P1 students of the three treatment groups in the pre-test on statistics were calculated by the ANOVA.

6. Differences between the means of P2 students in the three treatment groups in the pre-test on statistics were calculated by the ANOVA.

7. Differences between the means of P3 students in the three treatment groups in the pre-test on statistics were calculated by the ANOVA.

8. If initial differences in the means of different groups in the pre test on statistics were significant ANCOVA would be used for the analysis of the post test on statistics scores with the pre-test scores as covariate and post test scores as criterion.

If no significant differences were found in analysis of the pre test on statistics scores ANOVA was used for the analysis of the post test scores.

9. ANOVA was used for the analysis of the retention test scores to find out if the differences existed between the retention of
   - (i) P1, P2, P3 students of each treatment group.
   - (ii) P1 students of the three treatment groups.
   - (iii) P2 students of the three treatment groups.
   - (iv) P3 students of the three treatment groups.

10. Chi square was used for the analysis of the attitude towards mathematics questionnaires.

11. ANOVA was used for the analysis of time each group needed to complete the programme.

12. Pearson Product Moment Correlation coefficient was calculated for
    - (a) scores in the post test on statistics and
    - (b) (i) scores in Silent Reading Test
      - (ii) scores in Working with Numbers Test
      - (iii) scores in Five Dots Test

Correlation coefficients were tested for significance. Significant level for the analysis was 0.05.

CHAPTER 4

4.0 ANALYSIS AND PRESENTATION OF DATA

The study evaluated achievement of students of the three treatment groups measured by the post test on statistics. Retention of students was measured by the retention test identical to the post test on statistics but administered ten weeks after students have completed the programmed course. Time the P1, P2 and P3 students of the three treatment groups needed to complete the programmed course was measured by the tutors. An important consideration of the study was the change (if any) in attitudes of students of the three treatment groups towards mathematics after the students have completed the programmed course, measured by the two identical questionnaires, ones administered prior and one after programmed instruction.

Correlation coefficients were calculated for the scores of (i) achievement post test on statistics and (ii) (a) Silent Reading Test

(b) Five Dots Test

(c) Working with Numbers Test

All the correlation coefficients were tested for significance. Analyses were carried out by the author using a pocket calculator.

Presentation and analysis of the pretests results.

Students were pretested on the knowledge of statistics, reading ability, and attitudes towards mathematics. The means and standard deviations were calculated for each pretest. They are given in tables 8 to 15. All the figures are approximated to 2 decimal places.

TABLE 8

MEANS FOR THE SILENT READING TEST

Students	Treatment A	Treatment B	Treatment C
P1	24.94	26.05	23.50
P2	22.69	24.36	22.40
P3	19.40	21.96	17.55

TABLE 9

STANDARD DEVIATION FOR THE SILENT READING TEST

Students	Treatment A	Treatment B	Treatment C
P1	5.81	3.31	7.21
P2	4.48	5.31	2.83
P3	6.31	7.59	3.77

TABLE 10

MEANS FOR THE FIVE DOTS TEST

Students	Treatment A	Treatment B	Treatment C
P1	11.29	13.45	12.29
P2	8.61	13.21	10.00
P3	7.24	9.20	6.80

TABLE 11

STANDARD DEVIATIONS FOR THE FIVE DOTS TEST

Students	Treatment A	Treatment B	Treatment C
P1	3.56	2.56	3.56
P2	2.93	3.48	4.56
P3	3.37	3.50	2.89

TABLE 12

MEANS FOR WORKING WITH NUMBERS TEST

Students	Treatment A	Treatment B	Treatment C
P1	8.76	7.83	8.10
P2	7.39	8.27	6.28
P3	5.19	5.67	5.77

TABLE 13

STANDARD DEVIATION FOR WORKING WITH NUMBERS TEST

Students	Treatment A	Treatment B	Treatment C
P1	2.12	1.95	2.67
P2	2.59	2.00	2.54
P3	2.46	2.47	2.04

TABLE 14

MEANS FOR THE PRE-TEST ON STATISTICS

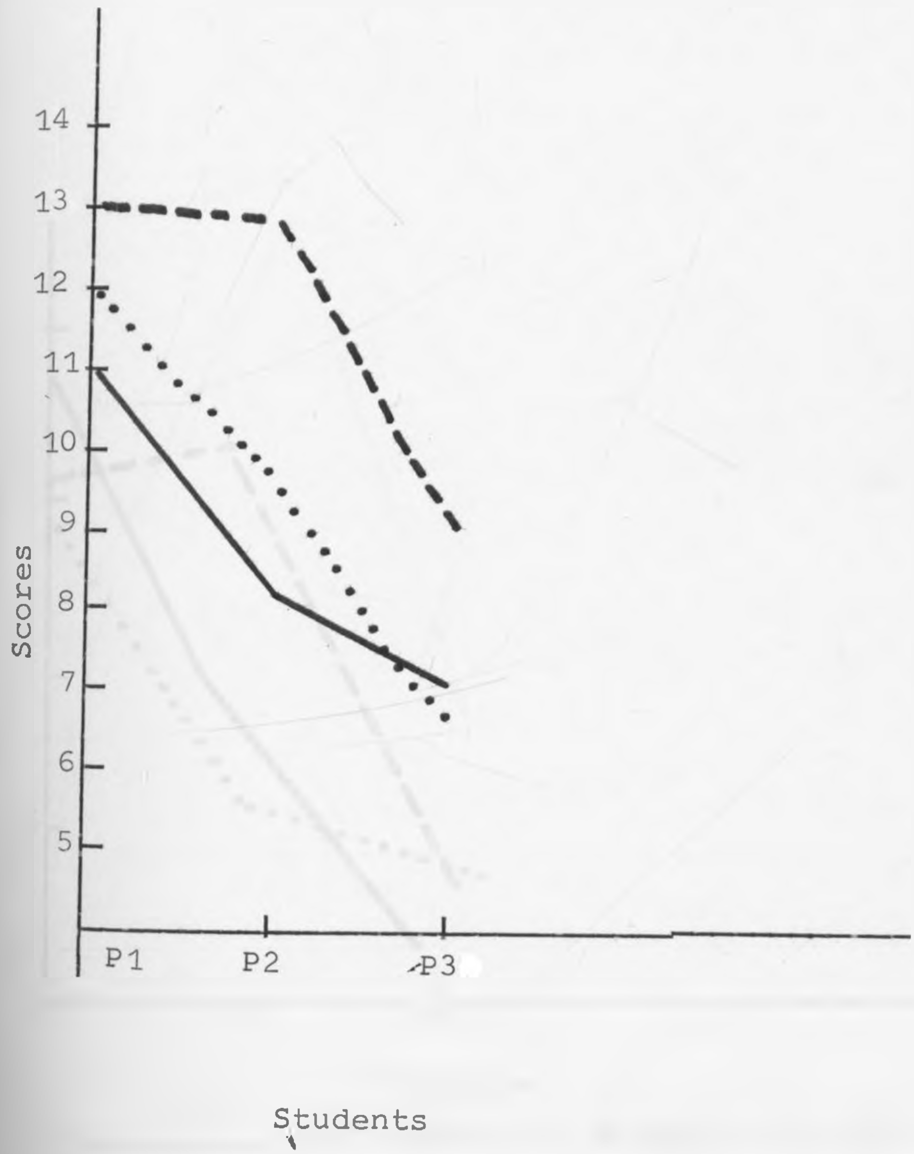
Students	Treatment A	Treatment B	Treatment C
P1	11.12	18.95	20.64
P2	14.22	19.68	14.20
P3	8.00	15.29	10.90

TABLE 15

STANDARD DEVIATIONS FOR THE PRE-TEST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	8.94	5.83	9.70
P2	6.01	8.00	8.40
P3	7.62	10.37	9.92

Figure 2: Performance of students in Five Dots Test.

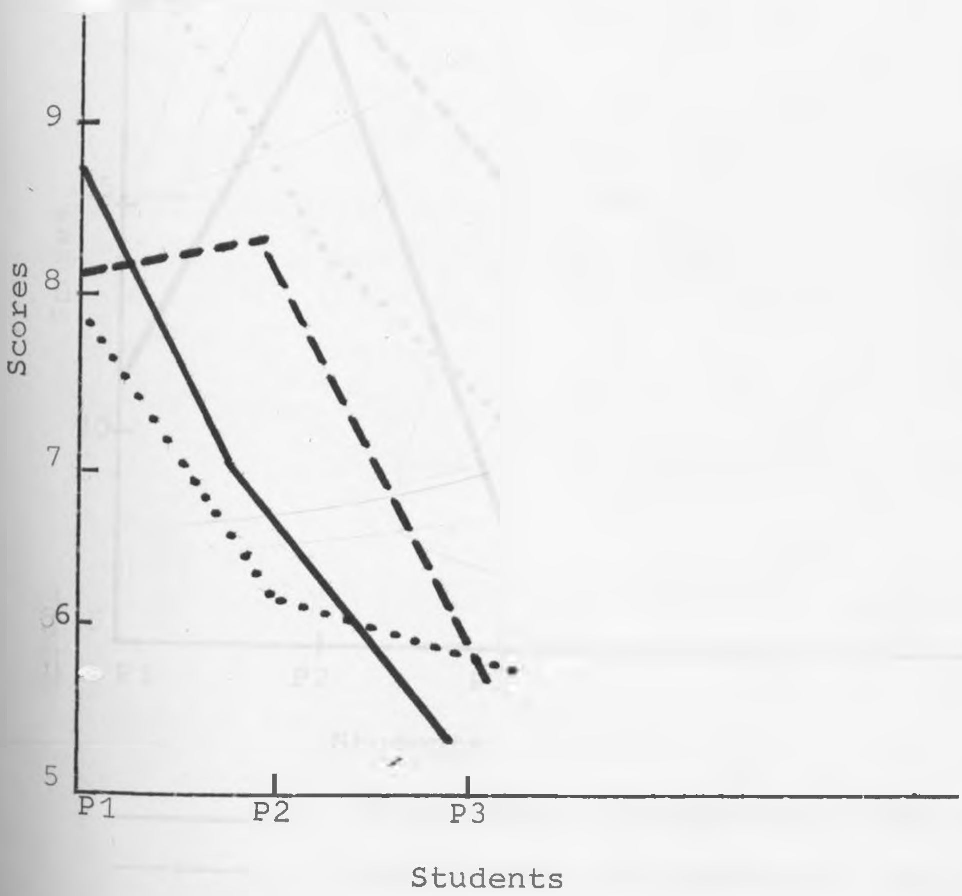


——————— performance of students of the treatment A

- - - - - - - - - performance of students of the treatment B

.... performance of students of the treatment C

Figure 3: Performance of students in Working with Numbers Test.

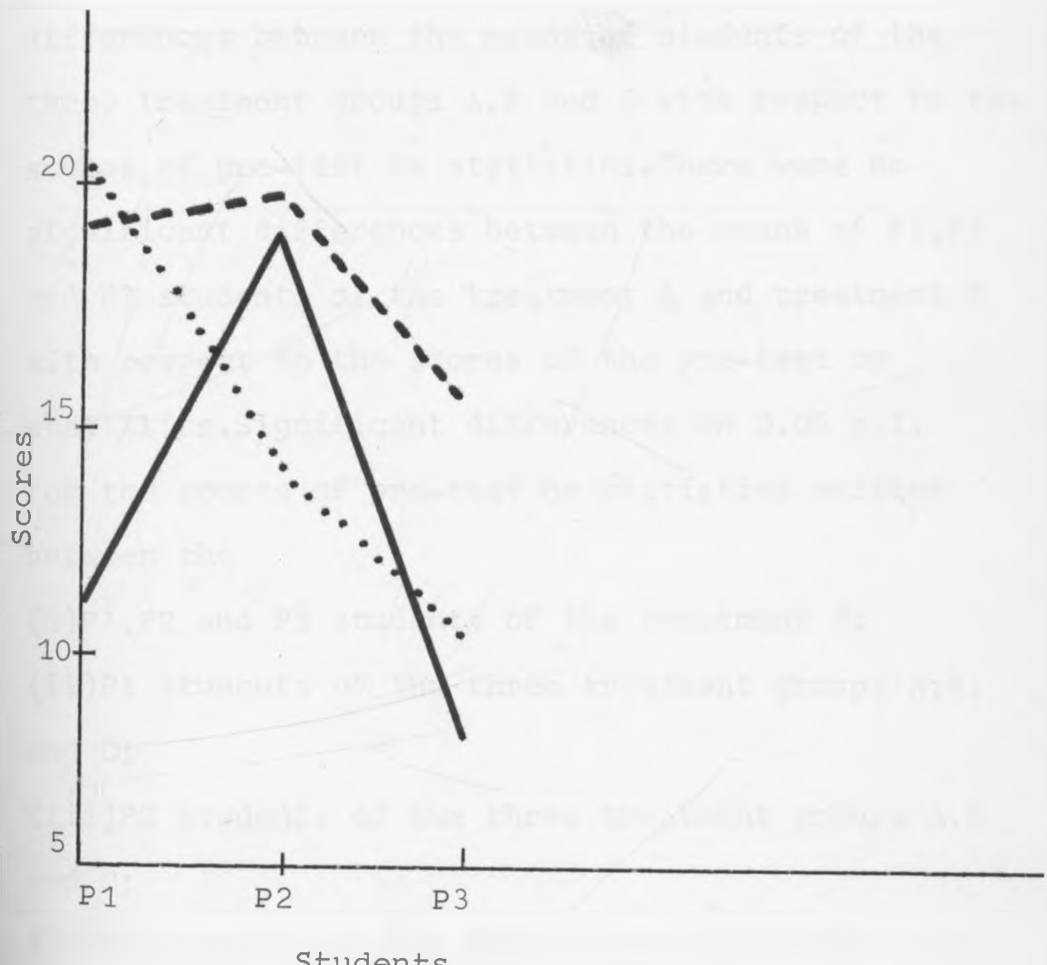


——————— performance of students of the treatment A

- - - - - - - - - - - performance of students of the treatment B

.... performance of students of the treatment C

Figure 4: Performance of students in the pre-test



———————— performance of students of the treatment A

- - - - - - - - - performance of students of the treatment B

.... performance of students of the treatment C

ANOVA was used to find out if there were any significant differences between the means of students of the three treatment groups with respect to the scores of pre-test on statistics. The results are given in the table 1[illegible].

The table shows that there were significant differences between the means of students of the three treatment groups A,B and C with respect to the scores of pre-test on statistics.There were no significant differences between the means of P1,P2 and P3 students of the treatment A and treatment B with respect to the scores of the pre-test on statistics.Significant differences on 0.05 s.l. for the scores of pre-test on statistics existed between the

(i)P1,P2 and P3 students of the treatment C;

(ii)P1 students of the three treatment groups A,B, and C;

(iii)P2 students of the three treatment groups A,B and C;

(iv)P3 students of the three treatment groups A,B and C.

TABLE 16

SUMS OF SQUARES, DEGREES OF FREEDOM AND CALCULATED F RATIOS FOR THE PRE-TEST ON STATISTICS

Source of variance	SS_B	SS_W	df_B	df_W	F	S.L.
Groups A,B and C	1660.12	14583.00	2	180	10.25	0.05 0.01
P1,P2 and P3 in group A	408.47	3806.88	2	57	3.06	*
P1,P2 and P3 in group B	264.42	4787.35	2	66	1.82	*
P1,P2 and P3 in group C	788.10	4528.22	2	51	4.44	0.05,
P1 in groups A,B and C	848.11	3277.93	2	48	6.21	0.05,
P2 in groups A, B and C	451.11	3841.75	2	60	3.52	0.05
P3 in groups A,B and C	657.44	6002.76	2	66	3.61	0.05

* $p > 0.05$

Presentation and analysis of the post tests results.

Post test on statistics was administered to students two days after the completion of the programmed course. The means and standard deviations were calculated and are given in tables 17 and 18.

TABLE 17

MEANS FOR THE POST TEST ON STATISTICS

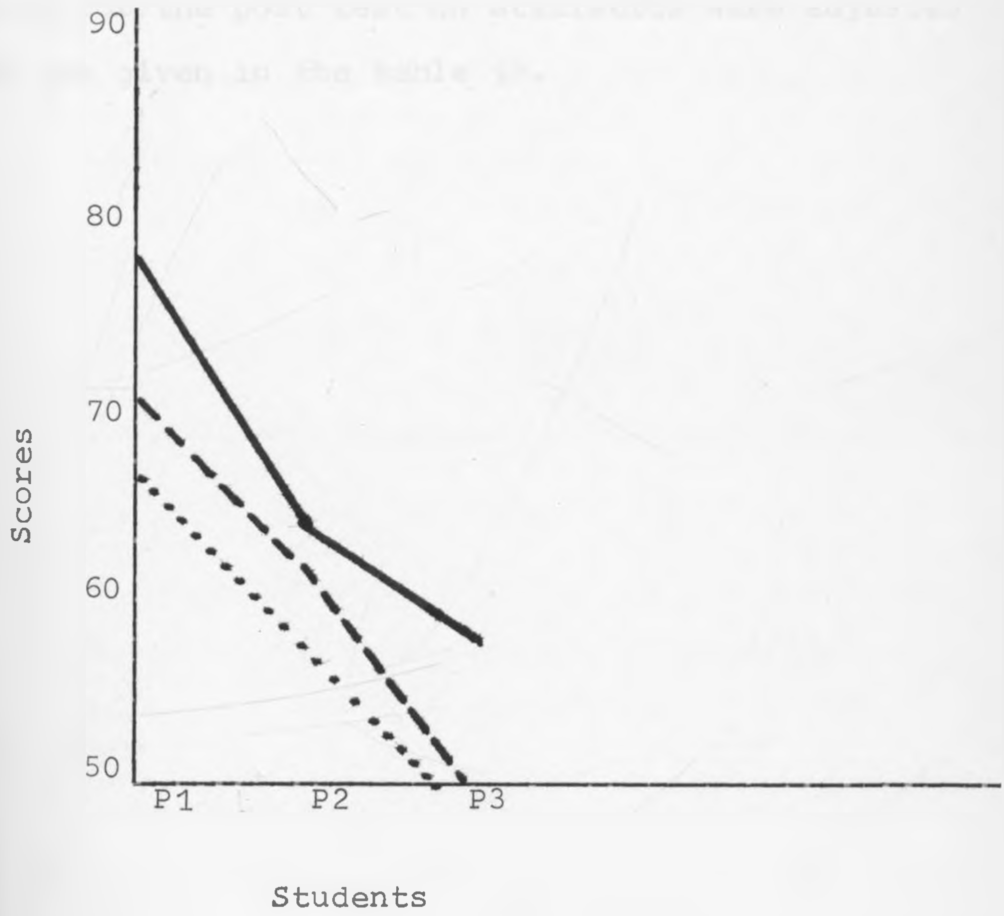
Students	Treatment A	Treatment B	Treatment C
P1	74.71	74.75	70.29
P2	62.72	66.40	54.85
P3	53.96	53.21	47.20

TABLE 18

STANDARD DEVIATIONS FOR THE POST TEST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	13.02	12.67	18.21
P2	11.98	13.76	12.36
P3	16.86	8.63	16.28

Figure 5: Performance of students in the post test on statistics



——————— performance of students of the treatment A in the post test on statistics

--------- performance of students of the treatment B in the post test on statistics

.... performance of students of the treatment C in the post test on statistics.

If there were significant differences found between the means of students of the three treatment groups with respect to the scores of the pre-test on statistics, ANCOVA was used for the analysis of post test on statistics. Means for the post test on statistics were adjusted and are given in the table 19.

TABLE 19

ADJUSTED MEANS FOR THE POST TEST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	78.92	73.16	67.44
P2	65.20	62.61	57.35
P3	57.22	49.44	47.66

Table 20 shows the adjusted sums of squares, degrees of freedom and calculated F ratios for the post test on statistics.

If no significant differences existed in the scores of the pretest on statistics ANOVA was used for the analysis of the post test. No significant differences were found between the means of:

(a) P1, P2 and P3 students of the treatment A

(b) P1, P2 and P3 students of the treatment B.

Table 21 shows the sums of squares, degrees of freedom and calculated F ratios in the ANOVA test for the scores of the post test on statistics.

TABLE 20

ANCOVA - ADJUSTED SUMS OF SQUARES, DEGREES OF FREEDOM AND CALCULATED F RATIOS.

Source of variation	SS_B^1	SS_W^1	df_B	df_W^1	F^1	s.l.
Groups A, B and C	2087.11	32785.66	2	179	5.70	0.05
P1,P2 and P3 in group C	0.36	7920.91	2	50	0.001	*
P1 in groups A, B and C	135.12	8036.11	2	47	0.40	*
P2 in groups A, B and C	582.37	5303.18	2	59	3.24	0.05
P3 in groups A, B and C	581.13	10921.02	2	65	1.75	*

* $p > 0.05$

TABLE 21

SUMS OF SQUARES, DEGREES OF FREEDOM AND CALCULATED F RATIOS FOR THE ANOVA IN POST TEST ON STATISTICS

Source of variance	SS_B	SS_W	df_B	df_W	F	s.l.
P1, P2 and P3 in group A	4356.83	22574.11	2	57	9.88	0.01 0.05
P1, P2 and P3 in group B	5246.58	12033.71	2	66	14.39	0.01 0.05

Retention post test was administered to students ten weeks after the completion of the programmed course. Means and standard deviations were calculated and are given in tables 22 and 23.

TABLE 22

MEANS FOR THE RETENTION TEST

Students	Treatment A	Treatment B	Treatment C
P1	53.76	54.55	42.79
P2	44.72	50.77	39.85
P3	37.12	38.75	33.85

TABLE 23

STANDARD DEVIATIONS FOR THE RETENTION TEST

Students	Treatment A	Treatment B	Treatment C
P1	14.24	22.69	12.29
P2	16.16	17.07	10.20
P3	15.24	8.34	11.75

ANOVA was used for the analysis of the retention test and results are shown in table 24.

Pretest on attitudes towards mathematics was administered before the programmed course. The identical questionnaire on attitudes towards mathematics was administered to students two days after the completion of the programmed course. Means were calculated for each item and Chi square was used to find if there were any significant differences in attitudes towards mathematics prior and after programmed instruction. The results are shown in tables 25, 26 and 27.

Pearson Product Moment correlation coefficients were calculated for the scores of

(i) post test on statistics and

(ii) (a)Silent Reading Test

(b)Five Dots Test

(c)Working with Numbers Test.

t test was used to find if correlation coefficients were significant. The results are shown in tables 28, 29 and 30.

TABLE 25

THE MEANS FOR EACH ITEM FOR THE QUESTIONNAIRE ADMINISTERED PRIOR TO THE PROGRAMMED INSTRUCTION (M1), AFTER THE PROGRAMMED INSTRUCTION (M2) AND THE CALCULATED CHI SQUARES.

Item	M1	M2	Chi square
1	-0.06	-0.71	5.20
2	-0.59	-1.12	2.45
2	-1.59	-1.65	0.10
4	-1.06	-1.00	1.32
5	-0.65	-1.00	1.00
6	-0.82	-1.00	1.35
7	-0.88	-0.35	1.80
8	-0.06	0.00	0.29
9	1.18	1.29	3.13
10	0.94	1.29	3.21
11	-0.65	0.29	6.67
12	-0.41	0.24	2.87
13	-0.24	0.65	4.41
14	-0.21	-1.76	2.75
15	-0.29	0.06	1.16
16	0.00	0.65	4.07
17	-0.53	-1.65	11.26*
18	0.41	0.18	0.20
19	0.41	1.18	5.94
20	0.47	0.88	3.53

$p < 0.05$

TABLE 26

THE MEANS FOR BOTH QUESTIONNAIRES AND THE CALCULATED CHI SQUARES FOR EACH ITEM

Item	M1	M2	Chi square
1	-0.04	-0.76	4.89
2	-1.28	-1.32	3.39
3	-1.76	1.52	2.03
4	-1.32	-1.16	4.47
5	-0.68	-0.68	0.00
6	-1.24	-1.24	1.25
7	-0.68	-1.08	2.94
8	0.00	-1.12	9.21*
9	0.96	0.84	3.00
10	1.44	1.52	2.30
11	0.64	0.76	0.11
12	-0.32	0.04	3.32
13	0.48	0.36	3.76
14	-1.08	-1.12	1.28
15	-0.16	0.04	0.38
16	-0.64	0.00	0.74
17	-0.40	-0.76	1.82
18	-0.16	0.08	1.31
19	1.04	0.92	2.38
20	1.32	1.12	3.27

* $p < 0.05$

TABLE 27

THE MEANS FOR BOTH QUESTIONNAIRES AND THE CALCULATED CHI SQUARES

Item	M1	M2	Chi square
1	0.79	-0.29	13.49*
2	-0.50	-0.71	2.58
3	-1.64	-1.21	2.51
4	-0.71	-0.71	1.46
5	-0.93	-0.93	1.30
6	-0.64	0.29	0.92
7	-0.36	-0.86	1.47
8	0.36	-0.07	1.89
9	1.07	1.14	0.19
10	0.93	1.22	1.29
11	0.36	1.21	4.13
12	-0.43	0.07	1.29
13	-0.29	0.36	2.29
14	-0.86	-1.07	0.86
15	-0.43	0.29	2.60
16	0.21	0.29	0.44
17	-0.57	-1.00	1.34
18	0.00	-0.21	0.31
19	0.21	0.79	0.83
20	0.57	0.59	0.20

* $p < 0.05$

TABLE 28

CORRELATION COEFFICIENTS BETWEEN THE SCORES OF SILENT READING TEST AND POST TEST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	0.77*	0.81*	0.32*
P2	0.55*	0.22	0.79*
P3	0.59*	0.86*	0.87*
$\overline{X}$	0.64*	0.63*	0.66*

* $p < 0.05$

TABLE 29

CORRELATION COEFFICIENTS BETWEEN THE SCORES OF FIVE DOTS TEST AND POST TEST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	0.29	0.90*	0.54*
P2	0.80*	0.31	0.13
P3	0.41*	0.95*	0.77*
$\overline{X}$	0.50*	0.72*	0.57*

* $p < 0.05$

TABLE 30

CORRELATION COEFFICIENTS BETWEEN THE SCORES OF WORKING WITH NUMBERS TEST AND POST ON STATISTICS

Students	Treatment A	Treatment B	Treatment C
P1	0.45*	0.54*	0.39
P2	0.21	0.43*	0.28
P3	0.54*	0.55*	0.34

* $p < 0.05$

Mean time and standard deviation each group needed to complete the programmed course were calculated and are given in tables 31 and 32.

TABLE 31

MEAN TIME NEEDED FOR EACH GROUP TO COMPLETE THE PROGRAMMED COURSE (IN HOURS)

Students	Treatment A	Treatment B	Treatment C
P1	5.29	3.50	3.00
P2	6.50	4.00	4.00
P3	6.84	5.33	5.00

TABLE 32

STANDARD DEVIATIONS FOR THE TIME EACH GROUP NEEDED TO COMPLETE THE PROGRAMME

Students	Treatment A	Treatment B	Treatment C
P1	0.96	0.92	0.00
P2	1.57	0.50	0.00
P3	1.49	1.18	0.00

4.1 Results

Significant differences in the post test on statistics were found between the students of the three treatment groups A, B and C. Students of the treatment A performed significantly better in the post test on statistics than students of the treatments B or C (t = 4.05, 126 d.f.). Students of the treatment B performed significantly better in the post test on statistics than students of the treatment C (t = 2.77, 120 d.f.). The null hypothesis that there is no significant difference between the means of students of the three treatment groups A, B and C with respect to the post test on statistics was rejected.

P1 students of the treatment group A performed significantly better in the post test on statistics than P2 or P3 students in the same treatment group (t = 2.75, 33 d.f.). P2 students of the treatment group A performed significantly better in the post test on statistics than P3 students in the same treatment group (t = 1.95, 41 d.f.).

The null hypotheses that there is no significant difference between the means of P1, P2 and P3 students in the treatment group A with respect to the post test on statistics was rejected.

P1 students of the treatment B performed significantly better in the post test on statistics than P2 or P3 students in the same treatment group ($t = 2.07$, 43 d.f.). P2 students of the treatment B performed significantly better in the post test on statistics than P3 students in the same treatment group ($t = 3.37$, 47 d.f.). The null hypothesis that there is no significant difference between the means of P1, P2 and P3 students of treatment B with respect to the post test on statistics was rejected.

There was no significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the post test on statistics scores. The null hypothesis that there is no significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the post test on statistics scores was accepted.

There was no significant difference between the means of P1 students of the three treatment groups A, B and C with respect to the post test on statistics scores. The null hypothesis that there is no significant difference between the means of P1 students of the three treatment groups A, B and C with respect to the post test on statistics scores was accepted.

There was a significant difference between the means of P2 students of the three treatment groups A, B and C with respect to the scores of the post test on statistics.

There was no significant difference between the P2 students of the two treatments A and B ($t = 1.07$, 36 d.f.). P2 students of the treatments A and B performed significantly better in the post test on statistics than P2 students of the treatment C ($t = 2.56$, 43 d.f.). The null hypothesis that there is no difference between the means of P2 students of the three treatment groups A, B and C with respect to the post test on statistics scores was rejected.

There was no significant difference between the means of P3 students of the three treatment groups A, B and C with respect to the post test on statistics scores. The null hypothesis that there is no significant difference between the means of P3 students of the three treatment groups with respect to the post test on statistics scores was accepted.

There was a significant positive correlation between the scores of

(i) post test on statistics and

(ii) (a) Silent Reading Test

(b) Five Dots Test

(c) Working with Numbers Test.

The three null hypotheses that there is no significant correlation between the scores of

(i) Silent Reading Test and post test on statistics

(ii) Five Dots Test and post test on statistics

(iii) Working with Numbers Test and post test on statistics were rejected.

There was a significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the time needed to complete the programmed course (F = 6.23, 2,57 d.f.). P1 students in group A took significantly shorter time to complete the programmed course than P2 or P3 students in the same group (t = 2.65, 33 d.f.). There was no significant difference in time needed to complete the programmed course between P2 and P3 students in group A. P1 students of the treatment group B took significantly shorter time to complete the programmed course than P3 students in the same group (t = 7.60, 22 d.f.). There was no significant difference between P1 and P2 students of the treatment group B with respect to the time needed to complete the programmed course. P3 students of the treatment B took significantly longer to complete the programmed course than P2 students in the same group (t = 3.60, 22 d.f.). No significant difference with respect to the time needed to complete the programmed course was found between P1 students of the treatment groups C and B. P1 students in the treatment group A took significantly longer to complete the programmed course than P1 students in the treatment groups B or C ($t = 4.75$, 26 d.f.). P2 students in treatment groups B or C took significantly shorter time to complete the programmed course than P2 students of the treatment group A ($t = 6.29$, 29 d.f.). P3 students of the treatment groups B and C took significantly shorter time to complete the programmed course than P3 students of the treatment group A ($t = 3.34$, 36 d.f.). The null hypothesis that there is no significant difference between the means of students of the three treatment groups A, B and C with respect to the time needed to complete the programmed course was rejected.

Significant difference in the attitudes towards mathematics questionnaires for the students of the treatment group A was found in item 17 (For a teacher it is more important to be good in English than to know Mathematics). The disagreement with the statement was significantly stronger in the questionnaires administered to students after they have completed the programmed course. For the students of the treatment group B the significant difference in attitudes towards mathematics occurred in item 8 (I do not feel sure of myself in mathematics). Significantly larger number of students disagreed with the above statement in the questionnaire administered to students after they have completed the programmed course.

For the students of the treatment group C the significant change in attitudes towards mathematics occurred in item one (I would like to teach English more than I would like to teach Mathematics.

More students disagreed with the above statement in the questionnaire administered after the programmed course.

P1 students of the treatment group A performed significantly better in the retention test than P2 or P3 students of the same group ($t = 1.76$, 33 d.f.). No significant difference was found between the means of P2 and P3 students of the treatment group A in retention test ($t = 1.56$, 41 d.f.). The null hypothesis that there is no significant difference between the means of P1, P2 and P3 students of the treatment A with respect to the retention test was rejected.

P1 and P2 students of the treatment group B performed significantly better in the retention test than P3 students of the same group (t = 3.05, 47 d.f.). No significant difference was found between the means of P2 and P3 students of the treatment group B in retention test (t = 0.62, 43 d.f.). The null hypothesis that there is no significant difference between the means of P1, P2 and P3 students of the treatment B with respect to the scores of the retention test was rejected.

The null hypothesis that there is no significant difference between the means of P1, P2 and P3 students of the treatment C with respect to the retention test was accepted.

P1 students of the treatment groups A and B performed significantly better in the retention test than P1 students of the treatment C. No significant difference was found between the means of P1 students of the treatment groups A and B in retention test (t = 0.22, 35 d.f.). The null hypothesis that there is no significant difference between the means of P1 students of the three treatment groups A, B and C with respect to the retention test was rejected.

There was no significant difference in retention test between the P2 students of the treatment groups A and B ($t = 0.72$, 41 d.f.) and between the P2 students of the treatment groups A and C ($t = 1.09$, 36 d.f.). P2 students of the treatment group B performed significantly better in the retention test than P2 students of the treatment group C ($t = 2.22$, 43 d.f.). The null hypothesis that there is no significant difference between the means of P2 students of the three treatment with respect to the retention test was rejected.

The null hypothesis that there is no significant difference between the means of P3 students of the three treatment groups A, B and C with respect to the retention test was accepted.

4.2 Discussion of the results.

Looking at the results the author concluded that one mode of presenting programmed material to students is more effective than the other with regard to the achievement of students. Individual programmed learning produced higher achievement post test scores than programmed learning in pairs or programmed learning in larger groups. Programmed learning in pairs was more successful with respect to the achievement post test than programmed learning in larger groups. P1 students who went through the programmed course individually or in pairs performed significantly better in achievement post test than P2 or P3 students. P2 students who went through the programmed course individually or in pairs performed significantly better in the achievement post test than P3 students. No significant difference in the achievement post test was found between P1, P2 and P3 students who went through the programmed course in larger groups.

No significant difference in the achievement post test was found between P1 students of the three treatment groups.

P2 students who went through the programmed course individually or in pairs performed significantly better in the achievement post test than P2 students who went through the programme in larger groups. No significant difference in the achievement post test was found between the P3 students of the three treatment groups.

There was a significant positive correlation between the scores of

(i) Achievement post test and

(ii) (a) Silent Reading Test

(b) Five Dots Test

(c) Working with Numbers Test.

Students who went through the programmed course in larger groups saved on time as compared to students who went through the programme in pairs. Pairs saved on time as compared to individual students. P1 students completed the programme in shorter time than P2 students. P2 students needed less time to complete the programme than P3 students.

P1 students who went through the programmed course individually or in pairs performed significantly better in the retention test than P2 or P3 students. No significant difference in the retention test scores was found between

P1, P2 and P3 students who went through the programme in larger groups. P1 students who went through the programmed course individually or in pairs performed significantly better in the retention test than P1 students who went through the programme in larger groups. No significant difference in the retention test scores was found between

(i) the P2 students of the three treatment groups

(ii) the P3 students of the three treatment groups.

CHAPTER 5

5.0 SUMMARY

The study involved the comparison of the three modes of presenting programmed material to the first year students in primary teacher training colleges in Kenya in their learning of Mathematics. Individual programmed learning was compared with programmed learning in pairs and programmed learning in larger groups. The subjects in the sample were 183 P1, P2 and P3 students from three randomly selected primary teacher training colleges in Kenya. The programme used was a linear programme on statistics. The study evaluated the achievement, attitudes,and retention of students. Correlation coefficients between the scores of achievement post test and scores in tests of reading and mathematical abilities were calculated and tested for significance. Another important variable measured in the study was the time different groups of students needed to complete the programme.

Achievement of students was found to be dependent upon the mode of presenting programmed material to students and upon their previous academic qualifications. Students who went through the programmed course individually performed better in the achievement post test than students who went throug.. the programme in pairs or in larger groups. Pairs performed better in the achievement post test than larger groups. There was no significant difference in the scores of the achievement post test between

(i) the P1 students, and

(ii) the P3 students of the three treatment groups.

Significant difference existed for P2 students of the three treatment groups. P1 students in all treatment groups performed better in achievement post test than P2 students who in turn did better than P3 students.

There was a significant gain in time needed to complete the programme for P1 students as compared to P2 or P3 students. Programmed learning in larger groups took less time than programmed learning in pairs or individual programmed learning. Students who went through the programmed course in pairs took less time than students who went through the programme individually. There was a high positive correlation between the scores in tests of reading and mathematical ability and achievement post test. Retention of students was found to be dependent upon the mode of presenting programmed material and students' previous academic qualifications. No siginificant changes in attitudes towards mathematics took place (except for one item) although the means of the post test attitudes towards mathematics questionnaire suggest more positive attitudes towards the subject.

5.1 Limitations of the study.

The study had several limitations and the most important ones are listed below.

1. Students' general ability was not measured as no proper measure exist. The achievement of students in the post test on statistics could be related to the general ability of students.

2. Emotional and mental state of students was not taken into account as it is very difficult to measure it. The emotional state of pupils could influence the results.

3. Variables like age of tutors, sex of tutors, experience, motivation, personality, and grade of tutors were not controlled.

4. Socio-economic background of students was not controlled.

5. Motivation of students was not controlled as it is very difficult to measure it.

6. No attempt was made to compare the achievement and the retention of students with their attitudes towards mathematics.

7. Students' reading and mathematical ability was not taken into account in the analysis of the achievement post test and retention test. As the correlation coefficients between reading and number work tests and post test on statistics were high students' reading and mathematical ability could influence the results.

8. The programme used in the study was too short for wider generalisation. The duration of the experiment was not long enough for any significant changes in attitudes towards mathematics to occur.

9. Students were aware that they were participating in the experiment and were excited about it. Programmed course presented to them a break in their usual school routine.

10. Differences in the results (for P1 students of the three treatment groups, P2 students of the three treatment groups, P3 students of the three treatment groups) could be partly attributed to the differences between the three colleges.

11. Financial and administrative problems did not allow to include more colleges or to assign treatments randomly to classes and not to colleges.

5.2 Findings

Based on the results of this study the author reached the following conclusions:

1. The three modes of presenting programmed material to the first year students in the primary teacher training colleges in Kenya in their learning of mathematics are not equally effective with respect to the

achievement of students. Individual programmed learning produced higher achievement post test scores than programmed learning in pairs. Programmed learning in pairs produced higher achievement post test results than programmed learning in larger groups.

2. P1 students performed better in achievement post test than P2 students who in turn performed better than P3 students.

3. The P2 students who went through the programme individually or in pairs performed significantly better in the achievement post test than P2 students who went through the programme in larger groups. This difference in perfomance in the achievement post test did not exist for P1 and P3 students of the three treatment groups.

4. There was a significant positive correlation between the scores of
   (a) achievement post test and
   (b) (i) Silent Reading Test
       (ii) Five Dots Test
       (iii) Working with Numbers Test.

5. There was no significant change in attitudes towards mathematics prior and after programmed instruction.

6. Students who went through the programme in larger groups took significantly shorter time to complete the programme than students who went through the programme in pairs. Students who went through the programme in pairs took significantly shorter time to complete the programme than students who went through the programme individually.

7. P1 students of any of the three treatment groups took significantly shorter time to complete the programme than P2 students. P2 students took considerably shorter time to complete the programme than P3 students.

8. P1 students performed significantly better in retention test than P2 students. P2 students performed significantly better in the same test than P3 students.

9.Retention of students was dependent upon the mode of presenting programmed material to them.P1 and P2 students who went throughhthe programme individually or in pairs performed significantly better in the retention test than P1 and P2 students who went through the programme in larger groups.

5.3 <u>Implications</u>.

Although the study did not evaluate the effectiveness of programmed learning and presently much used lecture method,the results suggest that programmed learning has an important place in primary teacher training colleges in Kenya.All the three modes of presenting programmed materials to students produced a significant amount of learning.Programmed learning would cater for individual differences among primary teacher training colleges in Kenya with respect to their educational background,general ability and motivation.In a short time primary teacher training students have to cover a wide range of academic and professional subjects.Taking into account the individual differences among the students it could be concluded that individual programmed learning is more effective than programmed learning in pairs or programmed learning in larger groups. Programmed learning is likely to change students' attitudes towards mathematics as it would give them a much needed confidence that they could master the subject matter.

The achievement of students in statistics in primary teacher training colleges in Kenya is affected by the mode of presenting programmed material to them and by students' previous educational background.Retention of students who have undergone a programmed course was found to be dependent upon the mode of presenting programmed material and their previous educational background.

5.4 Recommendations.

Programmed learning is recommended for primary teacher training colleges in Kenya.There is an urgent need for good locally written programmes covering mathematical topics for primary teacher training coleeges' students in Kenya.A special section should be established within the Kenya Institute of Education.The section would organise workshops for tutors of teacher training colleges and help them in writing programmes.The programmes could then be tried out in teacher training colleges and the successful ones could be widely used.The department could help teacher educators with necessary advice and materials. It could supervise the much needed research in the use of programmed materials in teaching of mathematics in primary teacher training colleges in Kenya.More research is needed using longer programmes and on the wider scale,before programmed learning in groups is disregarded as unsuitable for primary teacher training colleges.Size and structure of the group and selection of students in a pair might be an important factor influencing the achievement and retention of students.A study comparing the performance of students in homogenous and heterogeneous pairs should be carried out before the author can recommend or not recommend programmed learning in pairs.

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APPENDIX A

<u>Programme used in the study:</u>

Statistics for teachers.

Instructions to the student.

The programmed text is quite different from an ordinary textbook. A programme consist of the large number of frames, numbered 1, 2, 3 .... Each frame tells you something and asks questions about the material you have learned.

You should work at your own pace. Read each frame carefully and write the answer on the piece of paper. Then check your answer and see if you are right. If your answer is correct, go ahead to the next frame. If you are wrong, read the frame again. Practise with the following frames:

1. When a blank has nothing on it in brackets, you simply fill in whatever best fits the blank. for example, the day of the week that follows Friday is ________________.

2. When a blank has two answers in the brackets, you select the one that fits best. For example, a dog (is/is not) an animal.

Let us begin ! Start with frame 1 !

1. Suppose you are a teacher and you would like to find out how well your pupil can judge distance. You could stage an experiment. Put a target, an object that can be well seen some distance in front of the pupil. Ask the pupil how far away the object is. You would be interested in the difference between the distance the pupil reported and the true _______________ of the target.

2. You could move the target after each of the pupil's judgement asking the pupil to judge each new distance. You could collect many different judgements of the distance by changing the distance between the target and the _______________.

3. We refer to something that does not change during an experiment as a CONSTANT. If the distance between the pupil and the target does not change it (would/would not) be a constant.

4. Opposite of the constant is a VARIABLE. Variable is something that changes during an experiment. In our experiment the distance between the pupil and the target varies, so we would refer to it as a ______.

5. You might want to test how well your pupils remember things. For example, you might read a list of six letters. If the letters were m,t,s,p,g,k and the pupil repeated m,t,s,p,g,l the pupil would have repeated only __________ letters correctly.

6. Suppose you gave your pupil another set of six letters to repeat. If the letters were p,f,t,m,s,r, and the pupil repeated p,f,t,g,k,n he would have repeated only______ letters correctly.

7. You could continue the experiment giving your pupil many different sets of six letters and ask your pupil each time to repeat the letters. Since the number of letters to be repeated would always be six, the number of letters would be a (variable/constant) in our experiment.

8. Every time the pupil repeated the letters you could record how many of them he got co-rrectly. You would call this number of letters repeated correctly an OBSERVATION or a SCORE.

   If the pupil repeated four out of six letters correctly his score would be four. If a pupil repeated 3 letters correctly his score would be ___________.

9. If the pupil repeated all the letters correctly his score would be six. If the pupil repeated no letter correctly his score would be zero. The lowest possible score in our experiment would be zero and the highest possible score would be _______ when all the letters were repeated correctly.

10. Pupil's score in our experiment can not be greater than _______ and smaller than _____.

11. Because the pupil's score changes in our experiment it is called a _______.

12. All the possible scores that a pupil could get are 0,1,2,3,4,5 and _______.

13. Each number from zero to six could be a possible score in our experiment. The variable we are interested in the experiment is the number of letters repeated correctly by the pupil. We would say that each score from zero to six is a possible value of our variable. 3 (would/would not) be a possible value of our variable.

14. The smallest possible value of our variable would be zero and the largest would be _______.

15. We have used the term variable for things that change in our experiment. We call things that do not change in our experiment _________.

16. There are many variables a teacher might want to observe in the classroom. A teacher might be interested to know how tall his pupils are. As pupils are likely to have different heights our variable would be the height of pupils. If a teacher wants to find out about the weight of his pupils then the weight would be a __________ in his experiment.

17. The variable observed very often in the classroom by a teacher is the behaviour of his pupils. A teacher might want to know how well his pupils have mastered the topic, how fast they can run, how well they can remember etc. If a teacher wants to observe how well his pupils have understood a topic in mathematics he could give them a test. The marks pupils got in the test would be values of the ______ the teacher is observing.

18. If his mathematics test was marked out of 20 then the highest possible score a pupil could receive would be _________ if the pupil answered all the questions correctly.

19. If the pupil got all the items wrong in the mathematics test his score would be (zero/ten).

20. The variable observed by a teacher in mathematics test is the understanding of the topic in mathematics. The marks pupils get are the values of the variable. If the test is marked out of 20 then any number between zero and ______ could be a possible value of the variable.

21. After the teacher has marked the test he would record the marks. The record would be called DATA. If ten pupils' marks in mathematics test were 2,0,1,7,11,16,3,6,19,11 then these marks when recorded by the teacher would be called ________.

22. The marks in the frame 21 (2,0,1,7,11,16,3, 6,19,11) are our data. No pupil scored a mark of 10 so 10 is not our data but it is possible value of the variable observed in the test. 11 (is/is not) our data and it is also our possible value.

23. We refer to the (oberved/possible) value of a variable as data. A list of all the possible values could not be considered data. In the mathematics test of the previous frame 8 would be a possible value but it is not data as no student got the mark of 8 in the test.

24. A variable is something that (changes/does not change) in the experiment. Something that does not change in an experiment is called ______. Data is the list of all the (possible/observed) values of the variable.

25. It is often useful to distinguish between continuous and discrete variable. If you were to count the number of pupils in your class it would be possible to have 30 or 40 pupils but not 38½. This kind of variable is called a discrete variable since there are no values of the variable between 38 and 39, 40 and 41 or 30 and __________.

26 On the other hand the variable called length is an example of a continuous variable. No matter which particular pair of length you considered it would always be possible to have a length between the two. 150½ would be between 150 and 151, 166¼ would be between 166 and 167, 170¾ would be between 170 and __________.

27 Discrete variables are measured by counting and continuous variables by measuring. Any collection or group of things can be counted. Counting tells us the number of things that are in the group. We could find the number of eggs in the basket by _________ them.

28. Nairobi is a name of the capital of Kenya. We refer to the person's height with the name such as tall, short. We refer to the number of things in the group with the name such as ten, five, two. Red would be the name of a particular colour and twenty would be the _______ of a particular number.

29. Three, seven, fifty are the names of particular ___________.

30. There are different ways of presenting the same number. Number ________ could be presented as 12, XII or twelve.

31. Number is a charactristics of the group or collection of things. The names such as ten, two, four that are used to represent these characteristics are called numerals. Number ten could be written down as ten or 10 or in Roman numerals as _________.

32. Names such as red, tall, Nairobi are not the names of numbers so they are not numerals. Of the two names six and red, ________ is a numeral since it is a name of a particular number.

33. The number is often referred to as a variable. The variable called number has different particular values. Just as red, green, blue are names of particular values of the variable called colour so are 10, 15, 21 .... ________ of particular values of the variable called number.

34. Numerals are often used to represent characteristics of things other than numbers, such as weight, length, temperature, age. When we say that a pupil is 14 years old we are using numeral 14 as a name of a variable called age. When we say that the stick is 5cm long we are using numeral 5 as a name of the variable called ____________.

35. We have to be careful when numerals are used to represent characteristics other than numbers. It makes sense to say that 20 pencils are twice as many as 10 pencils or that 10kg. is twice as heavy as 5kg but we (can/cannot) assume that car no 20 in the East Africa Safari is twice as fast as car number 10. Number 20 on the car does not necessarily imply anything more about the car than the time of entry or category.

36. When we toss a die we could get 6 possible values. Those values are 1,2,3,4,5,6. Thus, any number between 1 and 6 (is/is not) a possible value of the variable "toss a die."

37. Each value of the variable "toss a die" is represented by the numeral. "Toss a die" is an example of (numerical/non numerical) variable.

38 When we toss a coin we could get "head or tail" as the possible values. Therefore "toss a coin" is an example of (numerical/non numerical) variable.

39. When we toss a die, we can get 1,2,3,5,______, and 6 as our possible values. If we tossed a die 3 times and we got 4,2, and 1 then 4,2, and 1 would be our data. It we tossed the die 7 times and got 1,1,6,4,3,6,5, then our data would be ___________.

40. If we tossed the coin five times and we got head, head, tail, tail, head, then our data would consist of 3 heads and ______tails.

41. If we tossed a die 3 times and got 4,2,3 then 4,2,3 (could/would not) be considered data.

42. Tossing a die will always give us six possible values. If we throw a die 100 times our data will consist of 100 values. "Tossing a coin" will always give us two possible values. If we throw a coin 50 times our data will consist of ___________values.

43. When we talk about a number we can say that 3 is more than (2/4).

44. We can say that number represented by the numeral four is twice as large as the number represented by the numeral _________.

45. We could also say that 8kg. is twice as heavy as (4/16)kg. We could also say that a temperature of 100°C is hotter than a temperature of (50/150).

46. We could not say that an athlete with no 4 on his jersey is twice as fast as an athlete with no _________ on his jersey.

47. We determine the number of objects in a set by counting the objects. We determine the values of a continuous variable by measuring it. We could find the number of chickens in the garden by ___________ them and the length of the string by _________it.

48. Measurement is assignment of numerals to a particular variable. Kilometers, hours, kilograms .... are units of measurement. Kilometers measure the variable called distance and the hours measure variable called (time/weight).

49. 20km. long journey is twice as long as 10km. long journey. The variable called volume is measured by (cm/cm^3).

50. It is often useful to list the things underneath one another in what it is called a COLUMN. The following list of numerals is arranged in a column. The list of colours is also arranged in a _________________

red	1
blue	3
green	5
yellow	6

51. When we list things side by side, we get a ROW. Look at the row of numerals below!

8 5 4 6 7 9

The list of colours below is also arranged in a ________.

green orange red purple white blue

52. The names of students below are arranged in a (row/column).

Jane Mary Peter Paul Hilda Anne

53. The letters below are arranged in a ______.

x

y

z

t

54. Here are the marks of five students in an English examination. The marks are listed in a (row/column).

John	78
Edith	46
Jane	65
Peter	66
Nancy	70

55. In the previous frame we had two columns placed side by side. In the first column we had names of pupils and in the second column we had (marks/ages) of pupils.

56. Two or more columns placed side by side form a TABLE. A table is an arrangement of things in rows and columns. The table in frame 54 has five rows and two columns. The table below has two rows and ________ columns.

a	b	c
x	y	z

57. Every numeral in the table falls in a particular combination of row and column. For example the numeral six in the table below is located at the intersection of third row and second column. The numeral 8 falls at the intersection of the first row and __________ column.

4	8	9	2
5	0	1	2
1	6	7	9

58. The table in the frame 57 has ______ rows and ________ columns.

59. It is often useful to present data in the form of a table. Suppose you wanted to observe your pupil's performance in Mathematics during the first term. You could give your pupils the first test by the end of January, the second test by the end of February and the third test by the end of March. The data could be recorded in a table.

Pupil	Test 1	Test 2	Test 3
Jane	40	45	45
Mary	50	55	60
John	55	55	55
Peter	35	40	35
Paul	45	60	70

The first column represents pupils' names and the other columns represent (marks/names) of pupils.

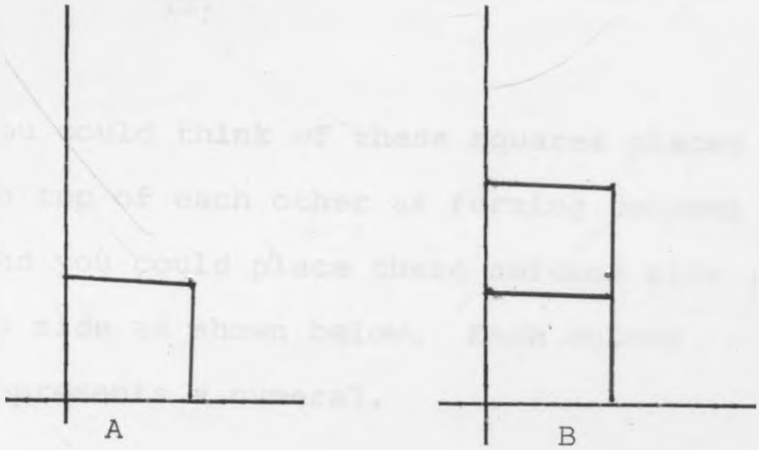
60. The mark John got in the second test was 55. The mark Mary got in the third test was______.

61. The pupil who achieved the highest marks in three tests was Paul as he got a total of____. The pupil who achieved the highest mark in the first test was_______, in the second was ________, and in the third test was _______.

62. You could find the test in which students did most poorly by comparing the columns. You could find the student who did most poorly by comparing the rows. The student who got the lowest marks in the three tests was ________.

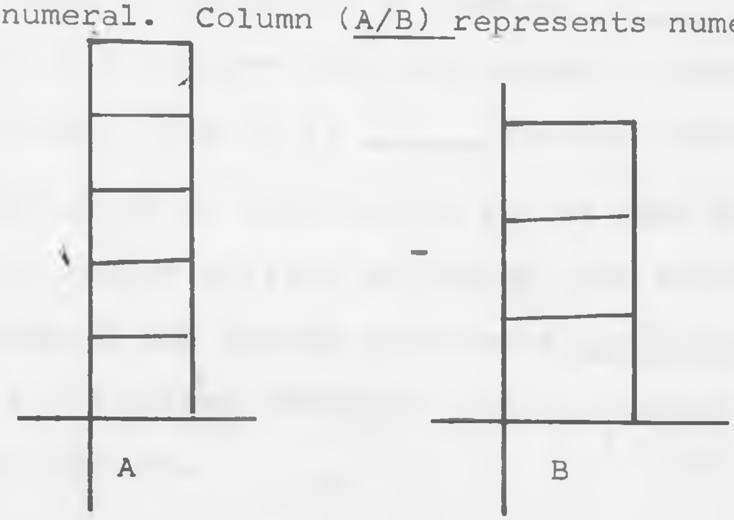
63. One way of presenting the list of values for certain variables is to arrange them in rows and columns. Such arrangement is called a _____________.

64. Another way to represent data is to draw it, to make a picture of it,to represent it graphically. If we represent numeral one with one square then numeral two could be represented by two squares placed on top of each other. Thus, drawing (A/B) below would represent numeral one and drawing (A/B) would represent numeral 2.

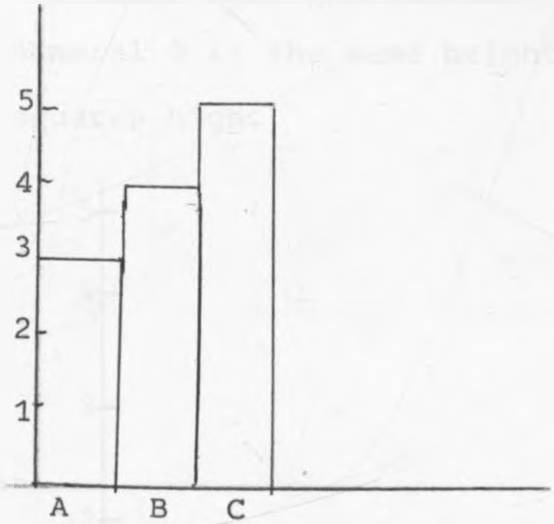


65. By adding the third square on top of the second one, we could represent numeral 3. Numeral 4 would be represented by 4 squares one on top of the other and numeral 8 would be represented by _______ squares.

66. You could think of these squares placed on top of each other as forming columns and you could place these columns side by side as shown below. Each column represents a numeral. Column (A/B) represents numeral 5



67. You could think of these squares placed on top of each other as forming columns and you could place these columns side by side as shown below. Each column represents a numeral.

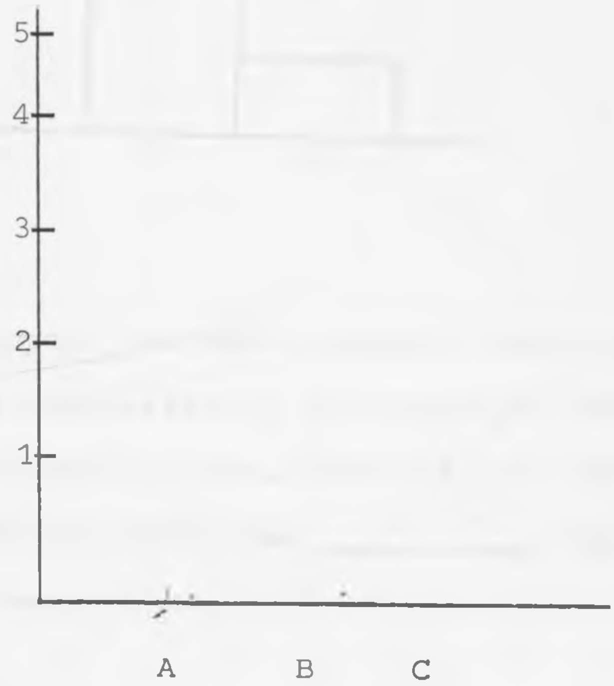


Column; A represents a numeral 3 as it is 3 squares high.

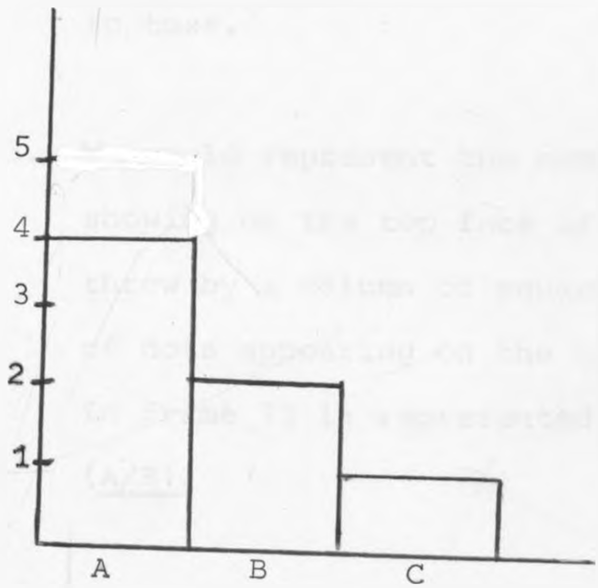
Column B represents a numeral _________ as it is 4 squares high and column C represents numeral 5 as it is _______ squares high.

68. The width of each column is the same but the height differs depending upon which numeral the column represents(width/height) of the column determines which numeral the column represents.

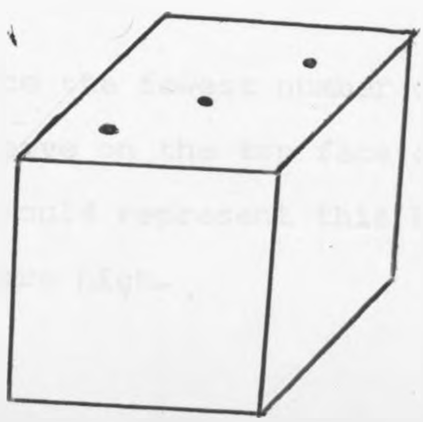
69. The three columns in frame 68 are shown below again. Now, however, we have drawn a line with marks on it to represent the different heights of the columns. The mark next to the numeral 3 is the same height as column 3 squares high, the mark next to the numeral ______ is the same height as column 4 squares high and the mark next to the numeral 5 is the same height as column ________ squares high.



70. In the figure below, column A is 4 squares high, column B is ________ squares high and column C is one square high.

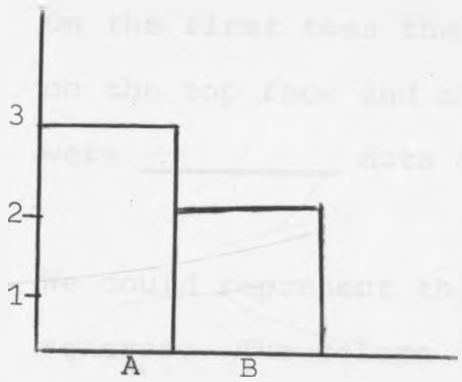


71. Suppose you were tossing a die, you might be interested in the number of dots appearing on its top face, when the die comes to rest. The die below has __________ dots on its top face.



72. The number of dots appearing on the top face of the die after each new throw (would/would not) be a variable since this number would change from toss to toss.

73. We could represent the number of dots showing on the top face of the die after a throw by a column of squares. The number of dots appearing on the top face on the die in frame 71 is represented by the column (A/B).



74. Since the largest number of dots which could appear on the top face of a die would be 6, the highest possible column of squares would be ____________ squares high.

75. Since the fewest number of dots we could observe on the top face of a die would be one, we would represent this by a column ________ square high.

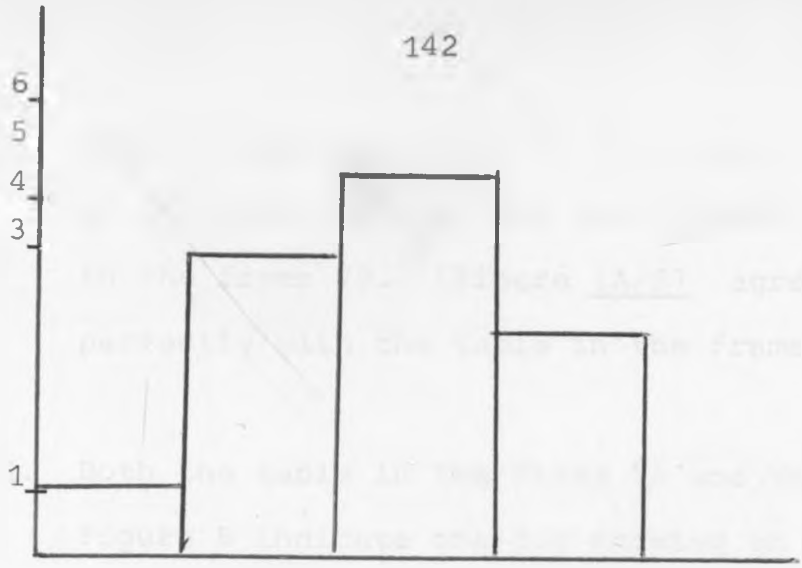
76. Suppose you tossed a die five times and recorded the number of dots showing after each toss on the top face of a die in the table below.

Toss	Dots showing
1	4
2	6
3	1
4	3
5	2

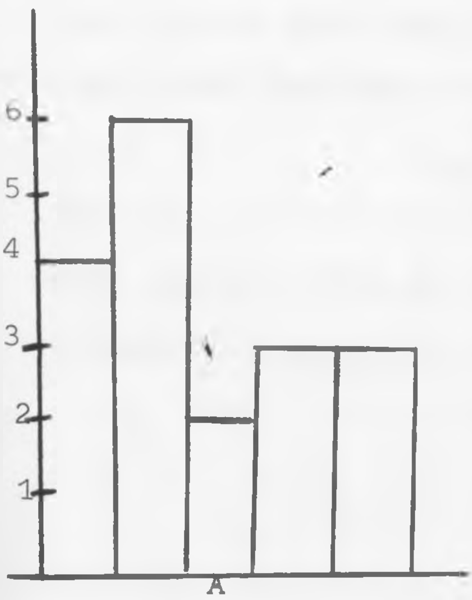
On the first toss there were 4 dots showing on the top face and on the fourth toss there were __________ dots showing on the top face.

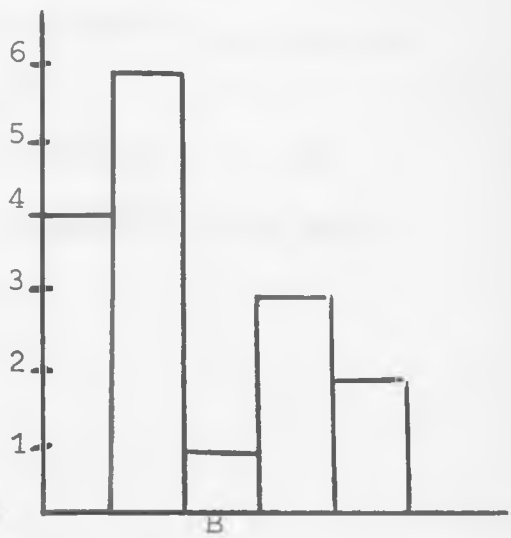
77. We could represent this data by columns of squares. The column for the first toss would be 4 squares high, and the column for the fourth toss would be _______ squares high.

78. The figure of this kind where the numerals are represented by the heights of the columns is called a BAR CHART. The figure below is an example of a __________.



79. Two bar charts are shown below. In the table in frame 76 it was indicated that there are 4 dots showing on the top face of a die after the first toss. Both figures A and B indicate that there are __________ dots showing on the die after the first toss because the column representing the first toss in both figures is 4 squares high.





80. Compare the data shown in the table in the frame 76 with the two figures in the frame 79. (Figure <u>(A/B)</u> agrees perfectly with the table in the frame 76.

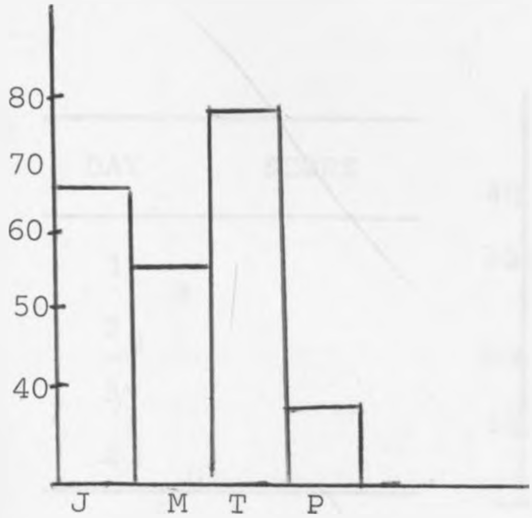
81. Both the table in the frame 76 and the figure B indicate one dot showing on the third toss, whereas figure A indicate ____ dots showing on the third toss.

82. Here are the marks of four pupils in mathematics examination.

Pupil	Mark (out of 100)
John	70
Mary	60
Tony	80
Peter	40

The highest mark was obtained by Tony and the lowest mark was obtained by __________.

83. The bar chart below represents the same data as the table in frame 82. Mary got a mark of __________.

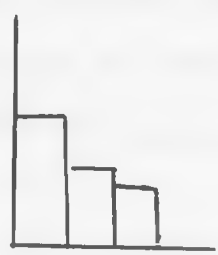


84. A table and a bar chart are drawn below.

The figure marked A is a <u>(table/bar chart)</u>.

6	8
5	4

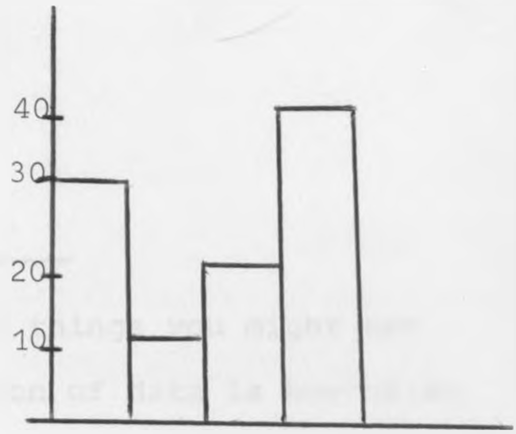
A



B

85. Another table and bar chart are drawn below. Complete the table so that it will be identical to the data shown on the graph. Now compare your work with the table given as the answer.

DAY	SCORE
1	
2	
3	
4	



86. Suppose you had a score of zero and you wished to represent it in a graph. If a column three squares high represented a score of 3, and a column two squares high represented a score of 2, and a column 1 square high represented a score of 1, then a column no squares high would represent a score of ____________.

87. Often you will see graphs in which the top of a column is at a height between two of the numerals or marks indicating values. For example, the following column would probably indicate the value (20/30/40) because it is lower than 40 but higher than 20, and approximately half-way between their marks.

89. One of the first things you might ask about a collection of data is how often were particular values of the variable recorded. For example the following table indicates a "score" of "8" was observed _______ times out of the 5 observations making up the data.

DAY	SCORE
1	8
2	8
3	2
4	5
5	8

The score value 5 occurred the same number of times as the value 2, since they each occurred __________.

90. You could characterise (describe) the data in the previous table by saying the value "______" appeared three times and the values "______" and "______" each appeared once. This summary of the data (would/would not) be sufficient if you were only interested in which score value occurred most frequently. The statement would tell you that the value "_____" was observed more often than any other value. The previous summary statement (does/does not) tell you enough about the data to determine on what particular day a score of "2" was observed.

91. Suppose you asked ten people to judge whether a particular painting was "good" or "bad". You might obtain data of the sort shown in the following table.

Person	Judgement
1	good
2	bad
3	good
4	good
5	bad
6	good
7	bad
8	bad
9	good
10	good

The two possible values of the"judgement" were "good" and "bad". According to the table the value "good" was observed ______ times and the value "bad" was observed _____ times. Another way of saying that the value "good" occurred 6 times is to say that the <u>frequency</u> of "good" was 6. Thus, the frequency of "bad" was ________.

92. If you said that the frequency of a certain value was 20, you would mean that you had counted the number of times that value had occurred in the data and found it had occurred _______ times. If a collection of data contained 8,8,2,9,6,6,5, the frequency of the value 8 would be ______ and the frequency of the value 5 would be 1.

93. To say a value has a frequency of zero means that the value occurred in the data _______ times. In the collection of data in the previous frame, the frequency of the value 10 is _______as the value 10 did not occur in the data.

94. Whenever we count things, we obtain a number. Since we count the values in the data to find their frequency, each frequency (is/is not) a number. One way of summarizing or characterizing data is to count how often each of the possible values of the variable occur. You could determine a frequency of occurrence for each of the possible values of the variable. Consider the following table of data.

Student	Grade
1	A
2	A
3	B
4	A
5	D
6	F
7	A
8	B
9	B
10	B

The grade A occurred 4 times, so its frequency is _______. The frequency of grade B is ________, the frequency of grade D is 1 and that the frequency of grade F is ________.

95. We should summarize this frequency information about the data in the previous table as follows:

Possible values of grades	Frequency
A	4
B	4
C	0
D	1
F	1

96. A table like the one in the frame 95 is called a frequency table **and** the one in the frame 94 is called a table of raw data. A table of raw data, and two frequency tables labeled Table A and Table B are shown below. The frequency table that corresponds to the table of raw data is Table (A/B).

Day	Weight
1	5
2	10
3	5
4	10
5	10
6	5
7	5
8	10

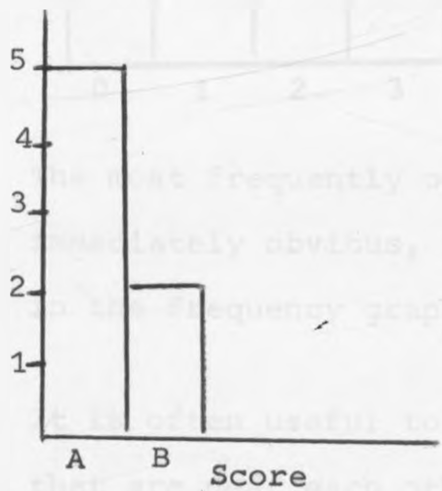
Weight	Frequency
5	5
10	3

TABLE A

Weight	Frequency
5	4
10	4
15	0

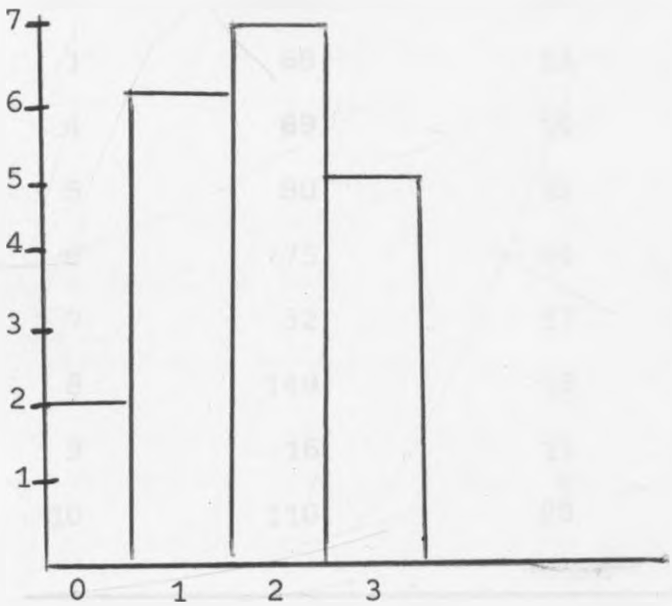
TABLE B

97. We could represent the data in a frequency table by means of a graph. We could represent the frequency of each value with the height of a column. The following frequency graph contains two columns. Score A has a frequency of _______ and score B has a frequency of _______.



98. A table and a _______ are shown below. The table and the graph (represent/do not represent) the same data.

Score	Frequency
0	2
1	6
2	7
3	5



99. The most frequently occurring score is immediately obvious, since the highest column in the frequency graph is the score of ________.

100. It is often useful to consider two observations that are near each other as having the same value. In other words, to group together observations that are sufficiently similar and to consider them as having the same value.

Suppose you gave your class a mathematical test (marked out of 150). The scores of the twenty pupils are given in the table below.

Pupil	Score	Pupil	Score
1	60	11	20
2	128	12	72
3	68	13	71
4	69	14	120
5	80	15	85
6	75	16	116
7	32	17	99
8	149	18	15
9	16	19	36
10	110	20	86

Notice there (is/is not) a score which occurs more than once in the table. Each observed score has a frequency of _______.

101. The highest score was _______, and the lowest score was _______.

102. Suppose we counted all the scores between zero and fifty. We would say that the frequency of scores between zero and 50 was five, since there are exactly five scores that were less than or equal to _______.

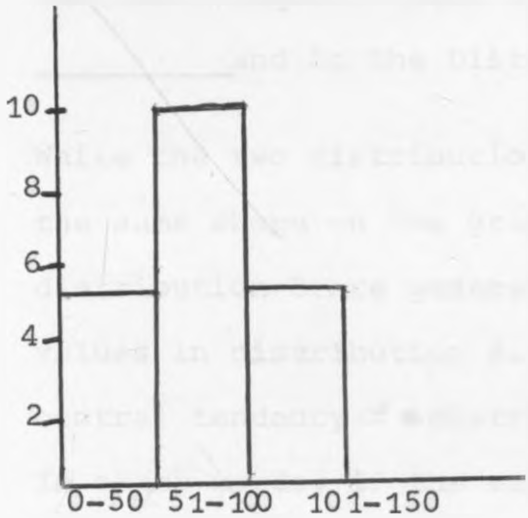
103. The frequency of the scores between 51 and 100 (including 51 or 100) would be ________ and the frequency of the scores between 101 and 150 would be ________.

104. We summarize these frequencies in the following frequency table of grouped data.

Scores	Frequency
0 - 50	5
51 -100	10
101 -150	5

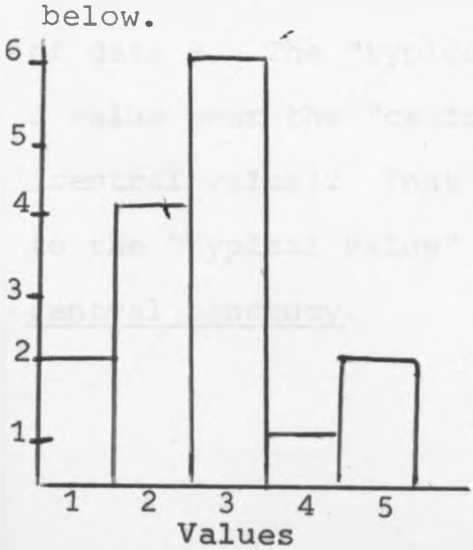
A frequency table of this sort is called a frequency table of grouped data as we have determined the frequency for groups of values, rather than the frequency for particular values. The most scores occurred between ________ and ________.

105. Data from the frequency table of grouped data can be represented by a graph. Below is a graph of the previous frequency table of grouped data.

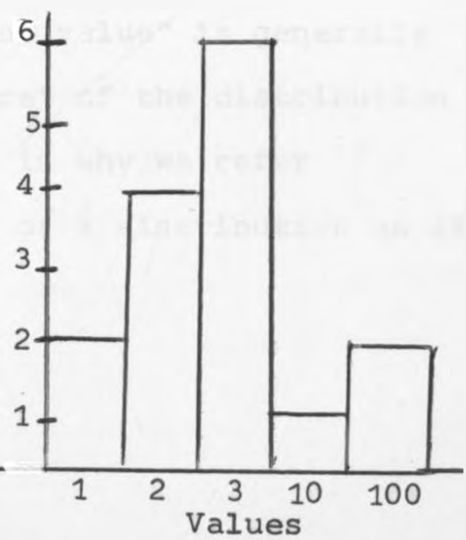


The frequency of the scores between zero and 50 is __________.

106. Any collection of data can be regarded as a distribution of values. By "distribution" we mean the number of times each of the possible values has been observed (recorded). Now, we shall consider some of the ways in which distributions differ and how these differences can be described. Consider for example, the two distributions shown below.



A



B

The most frequent value in the distribution A is __________ and in the Distribution B is ________.

107. While the two distributions have approximately the same shape on the graph, the values in distribution B are generally larger than the values in distribution A. We would say tnat tne central tendency of a distribution is larger. In other words, if the values in one collection of data are generally larger than the values in another collection of data you could say that the distributions of the two collections of data have (the same/different) central tendency.

108. Consider the two sets of data shown below.

Data A: **4,3,6,6,4,6,**

Data B: 21,23,20,21,23,20

You could describe data (A/B) as having larger values. We could say that the "typical value" of data B is larger than the "typical value" of data A. The "typical value" is generally a value near the "centre" of the distribution (central value). That is why we refer to the "typical value" of a distribution as its central tendency.

109. There is more than one way to define the typical value or central tendency of a distribution. If one value occurred more frequently in a distribution than any other value, you might consider that value the most common or typical value of the distribution. Therefore, one way of characterising the central tendency of a distribution (would/would not) be to report the most frequently occurring value in that distribution.

110. Statisticians use the most frequently occurring value in a distribution to characterise the central tendency of that distribution. The most frequent value of the distribution is called the mode. Thus, the value having the highest frequency in a frequency table (would/would not) be called the mode of the distribution represented in that frequency table.

111.

Pupil	Score
1	40
2	20
3	10
4	40
5	40

The value occurring most frequently in this collection of data is ______, since this value has a frequency of _____. The mode is the most frequently occurring value in a distribution, therefore, 40 is the ______ of the distribution shown in the table above.

112. A distribution can have more tnan one mode. For example, suppose you had a collection of data consisting of 10 observations of a variable with 3 possible values: a,b, and c. If the frequency of both a and b was 4, you <u>(could/ could not)</u> say that <u>both</u> a and b were modes in that distribution.

113. Consider the table of data shown below.

Observation	Value
1	11
2	11
3	21
4	11
5	21
6	33
7	11
8	21
9	21
10	33

The value 11 has a frequency of ________

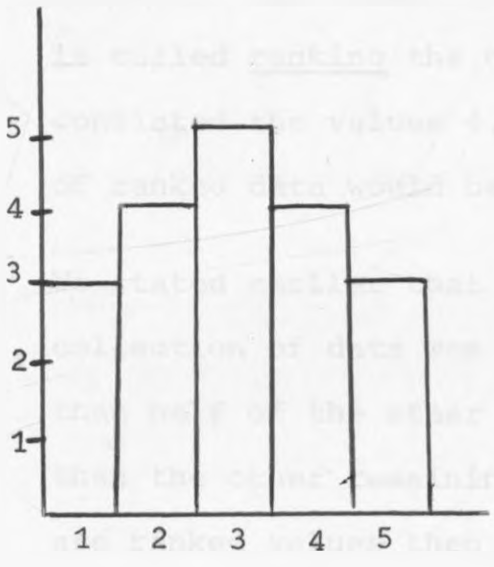
The value 21 has a frequency of ________

The value 33 has a frequency of ________

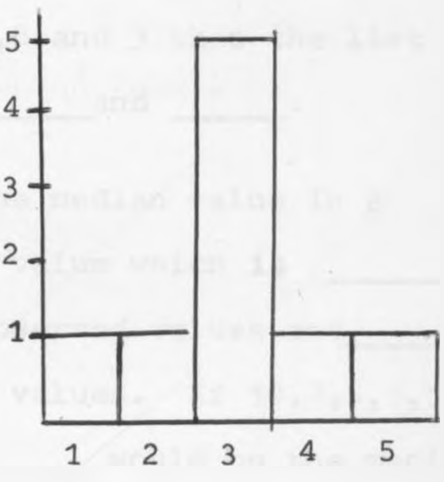
The two modes of this collection of data are the values ________and ________

114. Although the mode is often a useful way of characterising the central tendency of a distribution, it is sometimes misleading to describe a distribution by its mode.

Consider the two frequency distribution graphs shown below:



A



B

Notice how the mode of Distribution (A/B) is near the centre of the distribution.

115. Another way of representing central tendency is to report a value which is smaller than the same number of observations as it is larger than. This value is called the <u>median</u> of the distribution. For example, suppose your data consisted of the observations 4,5,7,8 and 10. The value 7 would be greater than <u>(3/2)</u> of the remaining observations and smaller than <u>(3/2)</u> of the remaining observations. Therefore, we could call ______ the median of these five observations.

116. The easiest way of finding the median of a collection of data is to list all the observed values in the order of their size. Tnis procedure is called <u>ranking</u> the data. If your data consisted the values 4,3,8 and 7 then the list of ranked data would be _____and ______.

117. We stated earlier that the median value in a collection of data was a value which **is** ______ than half of the other observed values and_____ than the other remáining values. If 10,7,6,2,1 are ranked values then ______ would be the median.

118. It is a simple matter to find the median of a distribution when you have an odd number of observations. You find the middle value in this list of ranked observations. This middle value would be the _____ of your data.

119. If you had an even number of observations there would not be a value in the list of ranked data such that the same number of observations fell above and below that value. To illustrate this problem consider the ranked data below. 80,60,40,30,20,10. Neither 30 or 40 is the median since too many values are smaller than (30/40) whereas too many values are larger than (30/40).

120. Strictly speaking, any value between 30 and 40 could be called the median of this data. However, statisticians have agreed upon a rule for finding the median of an even number of observations. They would say that the median of the previous collection of data was a value half way between 30 and 40. In other words 35 $\frac{(30 + 40)}{2}$ (would/would not) be called the median, because 35 is half way between 30 and 40.

121. Three lists of data are shown below:

Data A: 8,6,4,3,3,2

Data B: 6,3,2

Data C: 5,3,1,1

The median for Data A is ______, and the mode for Data A is ______.

122. The median of the collection of data 180,200, 160,100 is ______ as it is half way between 160 and _______.

123. The median (like the mode) can sometimes give a misleading picture of a distribution. For example, consider tne two collections of data shown below.

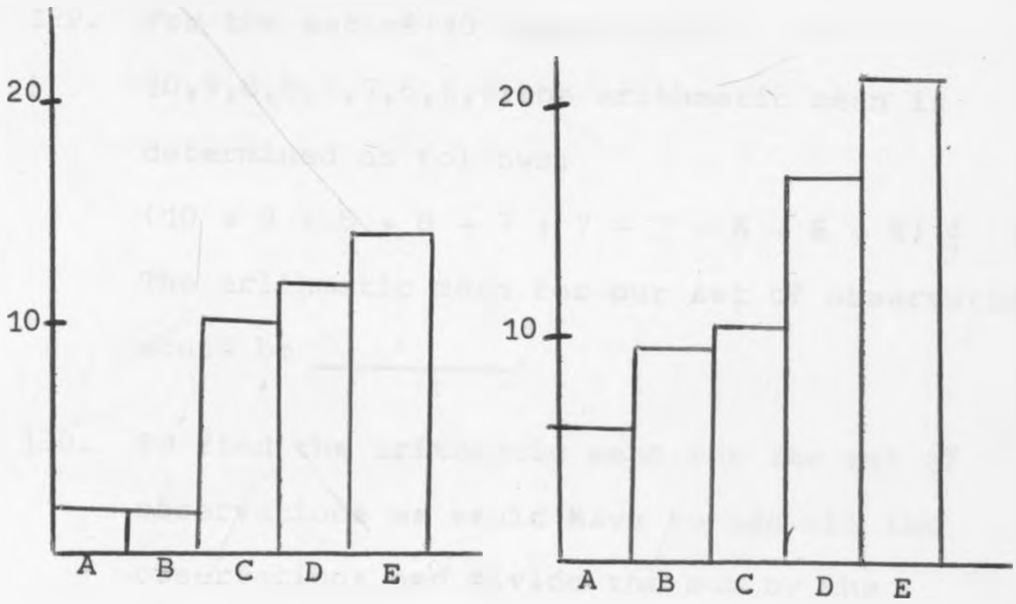
Data A: 100,99,98,97,96

Data B: 100,99,98,4,2

The median of Data A is ______ and the median of Data B is ______.

124. While both distributions have the same median, the values below the median in Data (A/B) differ much more from the median than do the values above it.

125. The median only indicates the value dividing the list of ranked data into two equal parts. The median does not indicate how much smaller or how much larger are the values falling above or below in the list. This can be illustrated by the following raw data graphs.



The median of both distributions is _____.

126. Remember, to find the median we have to arrange the data in order of size. The procedure is called ranking. If our data consisted of 4,3,8,9,5, then to rank the data we would get 3,4,5,8,9. The median would be _________.

127. For the data below 10,9,10,11,7,10,5,2,1,5, the mode is _______ and the median is ________.

128. The mode indicates the most ________value and the median indicates the value dividing the list of ranked data into two equal parts.

129. For the set of 10 observations 10,9,8,8,7,7,6,6,5 the arithmetic mean is determined as follows:

(10 + 9 + 8 + 8 + 7 + 7 + 7 + 6 + 6 + 5) ÷ 10.

The arithmetic mean for our set of observations would be _________.

130. To find the arithmetic mean for the set of observations we would have to add all the observations and divide the sum by the number of observations. If our set of observations consist of 3,4 and 5, then 3 + 4 + 5 would be ________. As we have 3 observations we would divide 12 by 3. The mean would be 4.

131. For the data below

8,1,1,2

the mean would be _________

as (8 + 1 + 1 + 4) ÷ 4 would be 3.

10 pupils scored the following marks in the English test marked out of 10

8,8,5,5,1,2,3,4,7,5.

The modal score is ________. The median is ________ and the mean is _________.

132. The arithmetic mean is a common way of representing central tendency of the distribution because its value depends on every value in a distribution. If an observed value is greater than

the mean it has positive deviation from the mean. If an observed value is smaller than the mean it has a negative deviation from the mean. For the set of observations 2,6,1, the mean is ________. 2 has a deviation of -1 from the mean as it is 1 less than the mean. 6 has a deviation of + ______ from the mean as it is by 3 greater than the mean.

133. We call the difference between the largest and the smallest value in a distribution of data a range. A range is not a measure of central tendency as mode, ______ and mean; it is a measure of variability of a distribution. For the set of observations 1,3,8,10, the largest value is ______ and the smallest value is 1. The range is 10 - 1 = 9.

134. For the set of observations 20,10,80,85,90, the range is _______.

135. A teacher gives his class an English test and marks it out of 100. The marks pupils scored are given below:

45,45,47,61,38,35,36,50,51,47,46,45,60,
61,44,47,35,33,25,22,80,82,32,30,29,27,
28,45,46,51,56

The teacher decides to group the marks in the classes of 10. The first class would be from 0 - 9, 0 and 9 included. How many pupils scored marks between 0 and 9?

136. The number of pupils scoring marks between 10 and 19 (both inclusive) is ______. The number of pupils scoring marks between 20 and 29 (both inclusive) is ________.

137. The teacher decides to draw up the frequency distribution table, representing each mark by a tally in the appropriate row.
The first score in the set of observation is 45. The teacher puts a tally in the same row as the class of 40 - 49 as a score of 45 lies between 40 and 49. The second score in our set of observations is 25. The teacher puts a tally in the same row as the class of (30 - 39/20 - 29).

138. The frequency distribution table for the marks in the frame 135 is drawn below. Complete it.

Class	Tally	f
0-9		0
10-19		
20-29		
30-39		
40-49		
50-59		
60-69		
70-79		
80-89		
90-99		0

139. There was no score in the classes from 0-9, ________, ________ and 90-99 so there are not tally marks there.

140. Marks are grouped in fives for easy counting like this. The tally marks II represent number ________.

141. The class which had the most marks was _____ and it is called the most frequent or modal class.

142. Complete the frequency distribution table for the scores below:
15,10,21,24,8,25,11,9,8,7,22,27,26,23,16,14,
13,14,15.

Class	Tally	Frequency
0-4		
5-9	1111	
10-14		5
15-19		
20-24		
25-29		

143. Modal class is the class which appears most frequently in the collection of grouped data. In our data in the frame 142 the modal class was from ______.

144. In the two tables below the largest observed value is ______and the smallest observed value is ______.

Obs	Value
1	1
2	4
3	5
4	5
5	5

Table 1

Obs	Value
1	1
2	1
3	1
4	8
5	9

Table 2

145. The mean for the table 1 is ______. The mean for the table 2 is _______.

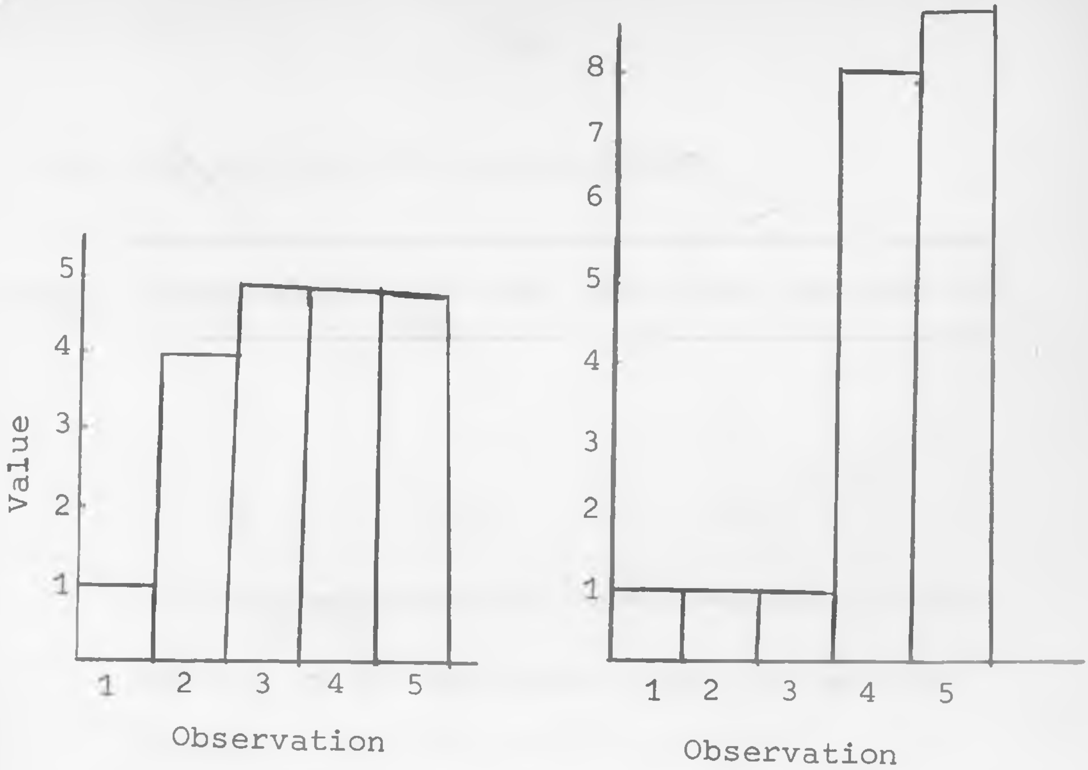
146. The mode for the data in table 1 is ______. The mode for the data in table 2 is ______.

147. The median for the data in table 1 is ____. The median for the data in table 2 is ____.

148. Range for the data in table 1 is ______, and the range for the data in table 2 is _____.

149. The observed values in table (1/2) are very close to the mean.

150. Let us represent the data in tables 1 and 2 in pictorial form (bar chart)



The values in data(1/2) are very close to the mean.

151. If you have a set of two observations 6,2 their mean would be ________. The deviation of observation 6 from the mean would be positive ________, and deviation of observation 2 from the mean would be negative ________.

152. For the set of 3 observations 8,3,1 the mean would be ______. The deviation of 8 from the mean would be ______ 4, the deviation of 3 from the mean would be negative ______ and deviation of observation 1 from the mean would be ________ ________.

153. For our set of 3 observations

Observation	Value	Dev. from the mean (4)
1	8	+4
2	3	-1
3	1	-3

The sum of all deviations would be zero as +4 + -1 + -3 = 0.

The sum of the deviations from the mean always equals 0.

If you have a set of 5 observations and their deviations from the mean were +8, -3, -5, +2, -2, the sum of the deviations would be ______.

154. For the set of observations 20, 10, 42, and 52, the mean would be ________, the deviations from the mean would be ________.

We have two sets of data below

Set A: 20, 22, 20, 18, 20

Set B: 2, 38, 20, 5, 36

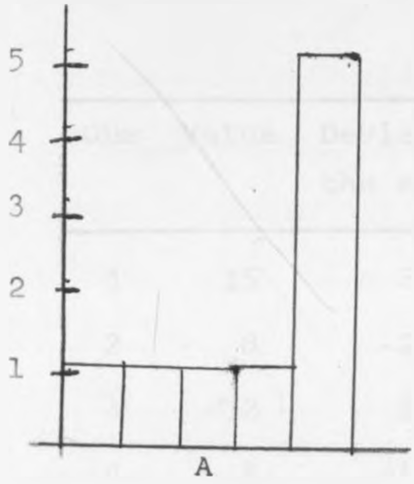
The more the values in a collection of data vary, the more variability that collection of data is said to have. Thus, we could say that the variability of data (A/B) was greater than the variability of the other collection of data.

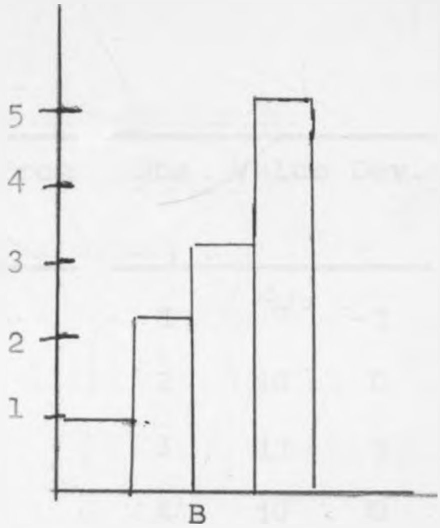
155. Data composed of many widely different values is said to have a great deal of variability. On the other hand, a collection of data in which the values are very similar is said to have little variability. Therefore, in one previous example data (A/B) would be described as having more variability than the other collection.

156. If the values in a collection of data are very similar, the data would not have much variability. If the values are very similar you would expect the difference between the largest value and the smallest value to be (large/small).

157. In other words we would say that data A have (large/small) range.

158. The range can sometimes give a misleading picture of the variability of a distribution. For example consider the following two frequency distribution graphs.





Notice that the range of distribution graph A is ________ and the range of distribution in graph B is _________.

159. Notice that the previous example all the values except one are identical in graph (A/B), whereas the values of the other graphs were all different. Therefore, even though both distributions have the same range, the distribution in graph (A/B) appears to be more variable than does the other distribution.

160. For the two collections of data in the tables below, the mean for data A is _______ and the mean for data B is _______.

Obs	Value	Deviation from the mean	Obs	Value	Dev.
1	15	5	1	9	-1
2	8	-2	2	10	0
3	12	2	3	11	1
4	5	-5	4	10	0

Table A Table B

161. Notice that the sum of deviations in table A equals ______ and the sum of deviations in table B equal ______.
It is clear that the values tend to be rather away from the mean in table (A/B) than they do in the other table.

162. We could represent the difference in variability by calculating the range in each collection of data. The range of the data in table A would be ________ and the range of the data in Table B would be ________.

163. The range is not the only statistics you can use to represent the variability of a distribution. There is another way of characterising the difference in variability of the two previous collections of data.

Notice that if we ignore altogether if deviation is positive or negative, the deviations in Table (A/B) tend to be larger than those in the otner table.

164. You can think of the variability of a collection of data as the degree to which the values are spread out from the mean. In other words, if all the values in a collection of data are very similar, they will all appear very close to the mean and the data will not have much variability. If the values of data are widely spread out, the deviations from the mean would tend to be very (large/small) and the distribution could be described as having a great deal of ________.

165. We pointed out how variability of a collection of data could be brought as a degree to which the observed values are spread out about the mean of that collection of data. The _______ is a useful resource of variability because it is the difference between the value having greatest positive deviation and the value having greatest negative deviation.

166. We also noted earlier that the range is not a completely satisfactory way of representing variability. Two distributions may nave identical ranges and yet one distribution may appear to be much more variable than the other. Consider the two collections of data shown in the following tables.

Obs	value
1	15
2	5
3	5
4	5
5	5

Obs	value
1	15
2	5
3	12
4	7
5	8

The smallest value in each table is ______.

167. The largest value in each table is _______.
The range of both collection of data equals _________.

168. While the range is the same in both collections of data, all the values except one is identical in data (A/B).

169. This illustration points up one of the disadvantages of the range as a way of representing variability. The range is determined by only two of the observed values in the collection of data

1) The ________ observed value, and
2) The ________ observed value.

170. In the two tables below the largest observed value is _______ and the smallest observed value is _______.

obs.	value	Dev.
1	1	-4
2	4	-1
3	5	0
4	5	0
5	5	0
6	10	5

Obs.	value	Dev.
1	1	-4
2	1	-4
3	1	-4
4	8	3
5	9	4
6	10	5

171. The mean for each collection of data is _____. Range for both tables _________.

172. The observed values in Table(A/B) are very close to the mean. All the values in the other distribution are almost as far away from the mean as the extreme values.

173. Even though the two extreme deviations in both collections of data are the same, the deviations in data (A/B) are greater than in other collection of data.

174. Let us represent data in tables A and B in the pictorial form.

175. Statisticians have found it useful to represent the variability of a distribution by the average of squared deviations from the mean. Whenever you square a number your answer will be positive regardless of what you are squaring is positive or negative For example $2^2 = 2 \times 2 = 4$
$(-2)^2 = (-2) \times (-2) =$ ________

176. Whenever a deviation is positive or negative, where you square it, your answer will be positive. If the deviation in one data is -4,

the squared deviation will be ________.

177. In the table of data shown below, we have listed 3 observed values, their deviations from the mean and the squared deviation. The mean of the data is _______.

Obs	Value	Dev. for	Squared Dev.
1	8	3	9
2	2	-3	9
3	5	0	0

178. The sum for all deviations from the mean in our table is _________. The sum of all squared deviations from the mean is ______ as 9 + 9 + 0 = _________.

179. If you want to find the mean (average) squared deviation, you should first add all the squared deviations and divide the sum by the number of observations. In our example the sum of all squared deviations was _______ and the number of observations was _____, so the mean square deviation will be 18 ÷ 3 = 6.

Statisticians refer to the mean (average) sq. dev. as the variance. Therefore, the variance of the previous collection of data is __________.

180. The variance is a statistic representing the variability of a collection of data. Values that are clearly spread out from the mean have large deviations from the mean. Whether these deviations are positive or negative, they will result in large squared deviations. Therefore, saying that a collection of data has a large variance implies that the data are spread from the _________.

181. A collection of data having the least possible variability would have, therefore, a variance equal to _______. It would also have a range equal to _______.

182. Consider the collection of data shown below:

Obs	Value	Dev. from the mean
1	8	
2	5	
3	5	
4	6	

The mean of this collection is 6. We have left room in the third column of the table to insert the deviation of each observation from the mean. Insert them.

183. Squaring the deviations you would get 4, _______, _______, and _________.
Variance would be ___________.

APPENDIX B

ATTITUDES TOWARDS MATHEMATICS

Instructions.

This is not a test. There are no right or wrong answers to any of the questions. Just answer them as honestly as you can. The questions ask you to tell how you feel about many different things. Your answer to each question should tell how you feel about it.

Circle the letter of the answer which tells best how you feel. Work carefully and quickly. Do not spend too much time on any one question. Answer all the items and give only one answer to each. You have 15 minutes.

1. I would like to teach English more than I would like to teach Mathematics.
   (A) strongly agree (B) agree (C) disagree (D) strongly disagree.
2. I have always been afraid of Mathematics.
   (A) strongly agree (B) agree (C) disagree (D) strongly disagree.
3. I can not see much value in Mathematics:
   (A) strongly agree (B) agree (C) disagree (D) strongly disagree.
4. I have never liked Mathematics:
   (A) strongly agree (B) agree (C) disagree (D) strongly disagree.

5. Mathematics is too difficult:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

6. Mathematics is boring:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

7. I avoid Mathematics because I am not very good with figures:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

8. I do not feel sure of myself in Mathematics:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

9. I do not think Mathematics is fun, but I always want to do well in it:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

10. I enjoy doing problems when I know how to work them well:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

11. I would like to spend more time in school doing mathematics:

   (A) strongly agree (B) agree (C) disagree

   (D) strongly disagree.

12. I never get tired of working with numbers:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

13. I think that Mathematics is most enjoyable subject:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

14. I can get along perfectly well in everyday life without Mathematics:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

15. Mathematics is easier for me than any other subject.

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

16. I would like mathematics better if it were not made so hard in class:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

17. For a teacher, it is more important to be good in English than to know Mathematics:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

18. I cannot understand how some students think mathematics is fun:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

19. I like Mathematics because it is practical:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

20. Mathematics is very interesting:

    (A) strongly agree (B) agree (C) disagree

    (D) strongly disagree.

TEST

(60 minutes)

Section A

Write down the letter corresponding to the correct answer.

1. A list of things listed underneath one another is called:

   (A) row (B) table (C) column (D) distributio

2. If a value is not recorded in the data, the value has a frequency of:

   (A) 0 (B) 1 (C) 2 (D) 3

3. The most frequently occurring value in a distribution is called:

   (A) mean (B) median (C) variance

   (D) mode

4. We refer to something that changes during an experiment as:

   (A) measurement (B) variable (C) constant

   (D) data.

5. Arrangement of things in rows and columns is called:

   (A) table (B) graph (C) data

   (D) distribution.

6. Of the ones listed below the measure(s) of the variability of a distribution is (are):
   (A) mode (B) range (C) standard deviation
   (D) mean.

7. A value in a collection of data which is smaller than half of the other observed values and larger than remaining values is called:
   (A) median (B) mean (C) mode (D) variance

8. A list of all the possible values in a variable "toss a die" is:
   (A) 1,2,3,6 (B) 0,1,2,3,4,5,6
   (C) 1,2,3,4,5,6 (D) 2,4,6

9. If a pupil gets 6 correct answers in a multiple-choice test and each correct answer scores 3 marks then the pupil's total score would be:
   (A) 20 (B) 6 (C) 12 (D) 18

10. If a test would be given to 10 pupils and their scores are recorded then these records would be called:
    (A) data (B) distribution
    (C) possible values (D) table.

11. An example of a continuous variable among the ones listed below is (are):

    (A) The scores obtained in an examination

    (B) Number of pupils in the class

    (C) Height of pupils in a class.

12. For the data below the mean is:

    8,5,3,4

    (A) 5 (B) 4 (C) 6 (D) 3

Section B

13. A test (out of 40) is given to 30 pupils. The scores pupils obtained are given below:

10,10,15,20,15,30,35,20,15,38,22,15,15,30,40,
40,10,11,19,14,26,20,25,35,10,30,30,19,21,20.

Calculate the mean score.

14. For the data in question 13 find the median.

15. For the data in question 13 find the mode.

16. For the data in question 13 find the range.

17. The following is the record of marks obtained by one class in the Mathematics examination:

25,63,82,12,57,38,17,23,56,96,58,62,54,19
56,55,45,50,44,43,19,3,51,52,57.

A teacher decides to group the marks in the frequency distribution table.

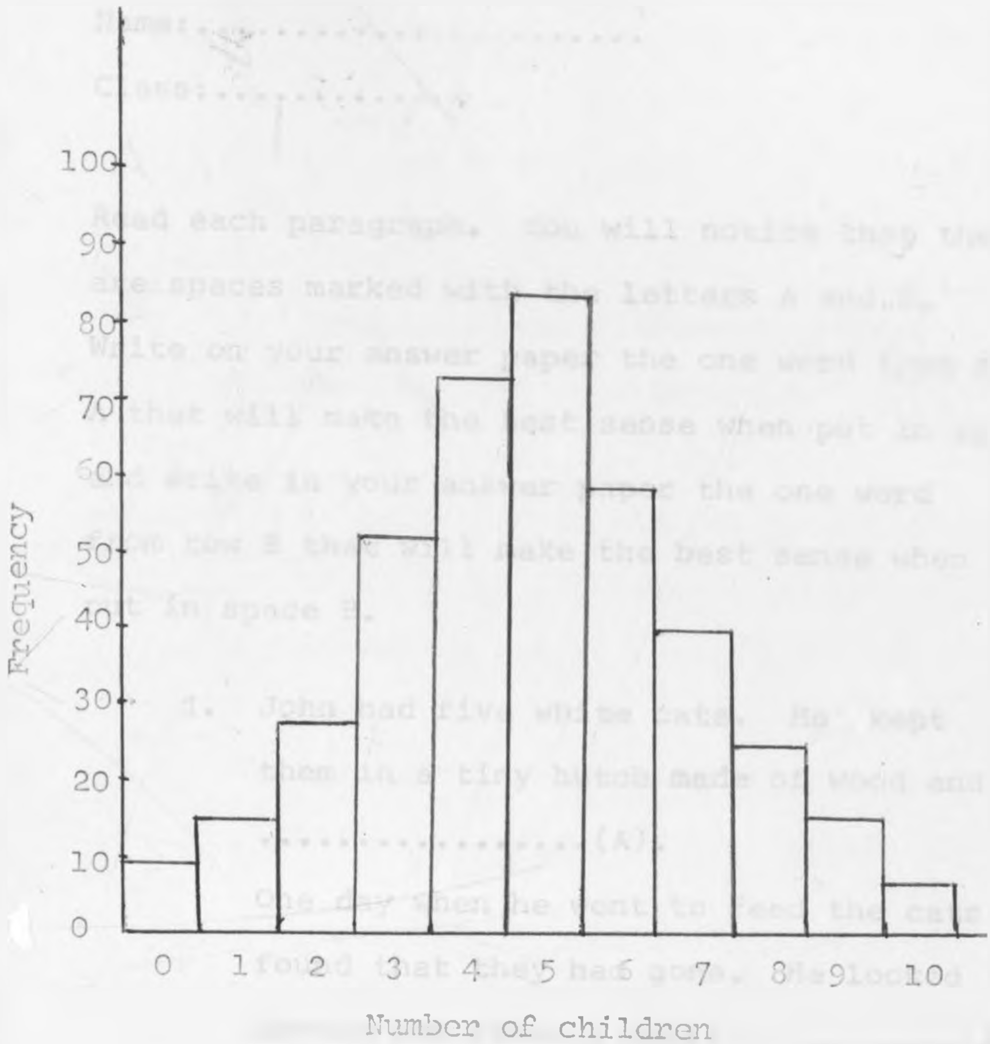
(i) Complete the table

(ii) Draw a bar chart for the table below, plotting the marks (classes) across the page and the frequencies up the page.

Class	Tally	Frequency
0-9	/	1
10-19	////	
20-29		2
	/	1
40-49		
60-69		2
70-79		
80-89		
90-99	/	1

18. For the data in question 17 find the modal class.

19. The bar chart in the next page shows the number of children in a family for a certain sub-location in Nyeri district. There was no family without a child and ten families had only one child. Look at the bar chart carefully and then answer the following questions.



How many families had

(i) three

(ii four

(iii)five

(iv)six or more children?

What was the modal number of children per family?

SILENT READING TEST

(Time 15 minutes)

Name:......................

Class:............

Read each paragraph. You will notice that there are spaces marked with the letters A and B, Write on your answer paper the one word from row A that will make the best sense when put in space A, and write in your answer paper the one word from row B that will make the best sense when put in space B.

1. John had five white cats. He kept them in a tiny hutch made of wood and ....(A).
One day when he went to feed the cats he found that they had gone. He looked around and found a small............(B) in the wire.
(A) bread, sand, wire, paper, leaves
(B) pot, nut, pole, stick, hole

2. They climbed the tall tree and all the birds flew out in fright. "Caw! Caw!" they cried. "Go away! You must not peep in at our ....(A).

But Tom and his friend climbed high, high up the tree till the houses looked very small and the sheep were like dots on the ....(B).

(A) game, hat, nests, books, dinner

(B) plate, river, house, trees, fields.

3. One day a poor fisherman was casting his net into the sea, hoping to catch some ....(A).

As he pulled in his net he saw in it a small glass bottle, but no fish. He picked up the ....(B) and looked at it. It seemed to be quite empty.

(A) wood, fruit, seaweed, fish, shells

(B) fish, rope, bottle, stick, shell.

4. The king had just had a good sleep, for it was a hot day. He drank a cup of tea and smoked a long pipe, and was happy. His chief servant came in, and crossing his ....(A) upon his breast bowed low before him.

"Sir," he said, "there is a pedlar outside, and he has many costly things in his pack."

"Bring him in at once," said the.......(B).

(A) feet, flowers, pipe, head, hands

(B) servant, man, pedlar, king, boy

5. Just then the moon came out, and they saw an owl perched up on a beam, and wiping the tears from her great, brown eyes. "Why do you weep?" asked the king.

"I am so ...."(A),said the owl. "I am not really a bird, but a princess. A wicked man gave me a magic drink which changed me into an ....(B).

(A) happy, sad, long, fat, glad

(B) owl, sparrow, woman, man, beam.

6. A boy's name was John Njoroge, so that each time he wrote his name he would write altogether ....(A) letters, and of these letters ....(B) of them would be the letter J.

(A) eight, ten, eleven, nine, twelve.

(B) two, five, three, four, six

7. A boy was once fishing, and he had by his side a very large can in which to put the fish he caught. So far he had caught nothing. A man who was passing saw that the boy had a bite and waited to see whether he would bring the fish to land or not.

He said to the boy, "How many fish have you caught, Peter?" The boy replied: "When I have caught this ......(A) and ....(B) more I shall have three.

(A) cold, line, two, worm, one

(B) bites, two, three, one, fish

8. The big brown lion, which lived among the dark, green forest trees of Mt. Kenya, hated the fire and the people who had it. He was greedy and wanted the mountain land all for ....(A), and he watched for a chance of putting out their ....(B).

(A) nothing, morning, himself, playing, others

(B) fire, food, cloth, home, garden

9. In Paris, in the old days, it was quite common to find very rich and very poor people living near to each other. In a large building the underground rooms might be rented by the very..........(A) while in the large chambers above, where there was plenty of air and light, might live people who were very ....(B).

(A) rich, poor, old, fat, tired

(B) poor, happy, rich, young, hungry.

10. Sunday was a different day for the rain was pouring down. As I was looking through the window I could see the people hurrying along the ....(A) pavement. In the afternoon the sun was ....(B) through the clouds and made the trees look as if they had stars on them.

(A) wet, green, large, tiny, dry

(B) reading, looking, writing, peeping, hoping.

11. Birds travelling long distances usually fly at night and are attracted by the bright lamps of lighthouses. In the past, thousands of birds have been killed by dashing themselves against the thick glass. Nowadays, many lighthouses have been fitted with special frames on which the.........(A) perch and rest, and this has saved the ....(B) of countless numbers of birds.

(A) lights, sailors, birds, storm, fish

(B) lives, ships, wings, flight, homes.

12. Two friends were travelling on the same road when they met a lion. The one, in great fear, without a single thought of his companion, climbed up into a tree and hid himself. The other seeing that he had no chance single-handed against the lion, had ....(A) left but to throw himself on the ground and feign to be dead; for he had heard that a lion will never touch a dead......(B) As he thus lay the lion came up to his head, sniffing at his nose and ears; but the man held his.........(C) and the lion, supposing him to be dead, walked away.

(A) nothing, something, only, perhaps, neither

(B) fly, leap, body, horse, orange

(C) hand, paw, coat, gun, breath.

13. When the lion was fairly out of sight, his companion came down of the tree and asked what it was that the lion whispered to him, "For," said he, "I observed that he put his mouth very close to your ear." "Why, "replied the other, "it was no great secret; he

only made me beware how I kept company with those who, when they get into a ....(A) leave their.........(B) to look after themselves."

(A) stream, difficulty, house, train, road

(B) money, pupils, goods, friends, horses.

14. Cotton goods cannot be made in every place. For spinning and weaving cotton well there must be moist air, plenty of water and plenty of coal. If the air is dry, the cotton threads snap when they are tightly stretched. The winds which blow across Central Province are moist or wet winds. They keep the air ....(A) so that ....(B) can be easily spun and ....(C).

(A) hot, dry, warm, moist, cool

(B) wool, plants, rope, clothes, cotton

(C) sold, woven, bought, coloured, worn.

15. The sailors who manned ships, too, made a mistake. There being a full moon and a low tide, the ships that had been grounded (for easier landing for the soldiers) were caught, badly anchored,

by the rising ....(A) and
several were dashed against each other
and ....(B).

(A) moon, soldiers, sun, fields, tide

(B) saved, painted, helped, lost
found.

Working with Numbers.

Instructions.

In this test there are 12 questions about working with numbers. Each question had five answer choices. You should circle the letter in front of the answer you choose. Here is an example of how you should mark your answers.

Example O.

Subtract 807 from 1,725.

(a) 819 (b) 918 (c) 928 (d) 1,018 (e) 1,622

The answer is 918, which is choice (b). See how choice (b) has been circled for example O.

You may use any paper in the exam paper for rough work. Do as many questions as you can. Do not spend too much time on any one question. You should only guess if you can rule out some of the choices.

You will have 20 minutes for the test

The first two questions are about ringtoss game. In ringtoss each player gets three rings to toss. Rings on the peg win 25 points each. Rings off the peg lose 10 points each.

1. David has two on and one off. How many points does he get?

   (a) 5 (b) 15 (c) 35 (d) 40 (e) 60

2. Bill has one on and two off. How many points does he get?

   (a) 5 (b) 20 (c) 25 (d) 40 (e) 45

3. What number does # stand for if 3 x 4 x 5 = 12 x # is a true statement?

   (a) 20 (b) 0 (c) 3 (d) 4 (e) 5

4. Which formula would you use to find how many stamps each person should get if 31 people share equally a package of 2325 stamps?

   (a) 31 ÷ 2325 = n (b) 2325 ÷ 31 = n

   (c) 2325 - 31 = n (d) 31 x 2325 = n

   (e) n = 2325 = 31

5. Suppose you decide to write fractions in a different way. For example, instead of ¾ we would write (3,4) and instead of 6/5 we would write (6,5). What would be the sum of (1,5) and (3,5)?

   (a) (3,5) (b)(4,5)(c) (3,10) (d) (4,10)

   (e) (3,25)

6. Suppose each of the following is true:

10@2 = 19 2@ 2 = 3 5@ 6 = 29 7@ 2 = 13

4@ 4=15 9@ 2 = 17

What does 6@ 3 equal?

(a) 6 (b) 3 (c) 9 (d) 17 (e) 18

7. Which of the following will always produce an odd number?

I. The sum of two odd numbers.

II. The sum of any three even numbers.

III. The sum of any three odd numbers.

(a) I only (b) II only (c) III only

(d) I and II only (e) I and III only.

8. The <u>sum</u> of two odd numbers less than 4 and the even numbers less than 9 is

(a) 11 (b) 13 (c) 24 (d) 42 (e) 45

9. If you multiply a number less than 1000 by one less than 100, then the greatest possible answer you could get is

(a) 98,901 (b) 100,000 (c) 1,000,000

(d) 998,901 (e) 99,999

10. If A = -BC then which of the following is (are) true?

(a) A/B = -C (b) A/-B = C (c) A/B = C

(d) A/-B = -C (e) A = BC

11. How many pieces of wood will you have if you cut across a long board 17 times a saw?

    (a) 16 (b) 17 (c) 18 (d) 19

    (e) none of these.

12. A chess club ran a weekly tournament in which every member played every other member just once. When one more member was admitted, it was found necessary to play 8 more games per tournament. Now how many members are there in the club?

    (a) 20 (b) 16 (c) 12 (d) 9 (e) 8.

Five Dots Test.

Name:..........................

Class:.........................

The questions in this test are based on five dots in a row. There is 1 cm between each dot. Each dot is named with a capital letter as shown below.

P	Q	R	S	T
.	.	.	.	.

We agree to give each dot many names. Since dot S is 2 cm to the right of dot Q, we will say that another name for dot S is Q2. The 2 is written on the right of Q as dot S is to the right of dot Q. Another name for dot S is R1 because S is 1 cm to the right of dot R.

When we write an equal sign between two names, we say we have two names for the same dot.

S = Q2 or Q2 = S are true statements because Q2 and S are names of the same dot.

P3 = Q is a false statement because P3 and Q are not names of the same dot.

Another way of naming dot S is 1T. Here the 1 is written to the left of T as dot S is to the left of dot T. We could write S = 1T.

Two more names for dot S are OS and SO (the O is zero) because the dot which is 0 cm from dot S is dot S itself.

There are 7 names for dot S. They are S, OS, SO, R1, Q2, P3, and 4T. See if you can think of 7 names for dot R.

S2 looks like a dot name but it is not because there is no dot 2 cm to the right of dot S.

All the questions in this test are about dot names.

You may read the explanation any time during the test.

Here are some practical examples:

Example 0.

Q2 =

(A) P—— (B) Q (C) R (D) S (E) T.

The correct answer is S, which is choice (D). See how choice (D) has been circled for example 0.

Example 00.

Q___ = S

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4.

The correct answer for the example 00 is choice (C). You should have circled (C).

Example 000.

___Q = P

(A) 0 (B) 1 (C) 2 (D) 3 (E) 4.

The correct answer for the example 000 is choice (B).

Work as quickly as you can. You should guess only if you can rule out some of the choices. <u>Do not guess wildly.</u> You have <u>15 minutes</u> for the test.

1. P3 = ___
(A) P (B) Q (C) R (D) S (E) T.

2. 2R = ___
(A) P (B) Q (C) R (D) S (E) T.

3. OT = ___
(A) P (B) Q (C) R (D) S (E) T.

4. R = ___ T
(A) O (B) 1 (C) 2 (D) 3 (E) 4.

5. ___ T = Q
(A) O (B) 1 (C) 2 (D) 3 (E) 4.

6. 4 ___ = P
(A) P (B) Q (C) R (D) S (E) T.

7. O ___ = R
(A) P (B) Q (C) R (D) S (E) T.

8. If T = X4, then X = ___
(A) P (B) Q (C) R (D) S (E) T.

9. If XO = Q, then X = ___
(A) P (B) Q (C) R (D) S (E) T.

10. If Pn = S, then n = ___
(A) O (B) 1 (C) 2 (D) 3 (E) 4.

11. If T = Rn, then n = ___
(A) O (B) 1 (C) 2 (D) 3 (E) 4.

12. If nS = R1, then n = ___
(A) O (B) 1 (C) 2 (D) 3 (E) 4.

By using the symbols ( ) more names can be given to a dot. For example, (P1)2 names the dot which is 2 cm right of the dot P1. Dot P1 is Q. Thus, (P1)2 is another name for dot S.

The name 3((P1)2) names a dot 3 cm left of (P1)2. We have just shown that (P1)2 = S.P is 3 cm to the left of S. Thus, 3((IP1)2) = P.

Now answer the following questions.

13. (2T)1 = ____

(A) P (B) Q (C) R (D) S (E) T.

14. If 2 (Q3) = X, then X =
(A) P (B) Q (C) R (D) S (E) T.

15. ((P1)1)2 = ____
(A) P (B) Q (C) R (D) S (E) T.

16. If T = (X1)2, then X = ____
(A) P (B) Q (C) R (D) S (E) T.

17. If (2R)n = R, then n = ____
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4.

18. If (nS)2 = S, then n = ____
(A) 0 (B) 1 (C) 2 (D) 3 (E) 4.

P Q R S T

APPENDIX C

Item analysis

Silent Reading Test

No. of Item	Mean	Variance	%not answered	Difficulty Index
1	1.86	0.22	0	0.93
2	1.81	0.01	0	0.91
3	1.71	0.35	0	0.86
4	1.62	0.33	0	0.81
5	1.81	0.25	4.76	0.91
6	1.67	0.41	4.76	0.83
7	1.38	0.71	4.76	0.69
8	1.62	0.43	0	0.81
9	1.81	0.35	4.76	0.91
10	1.52	0.44	4.76	0.76
11	1.62	0.33	4.76	0.81
12	2.67	0.51	4.76	0.89
13	1.81	0.25	4.76	0.91
14	2.19	0.65	4.76	0.73
15	1.19	0.63	4.76	0.60

Working with Numbers Test

No of Item	Mean	Variance	% not answered	Difficulty Index
1	0.80	0.33	0	0.81
2	0.81	0.36	0	0.82
3	0.76	0.20	0	0.74
4	0.72	0.36	0	0.71
5	0.68	0.35	4.76	0.69
6	0.71	0.44	9.52	0.72
7	0.72	0.42	9.52	0.73
8	0.65	0.25	14.28	0.66
9	0.50	0.44	50.46	0.51
10	0.48	0.22	50.46	0.50
11	0.48	0.28	80.92	0.49
12	0.44	0.29	80.92	0.44

Five Dots Test

No. of Item	Mean	Variance	% not answered	Difficulty Index
1	0.90	0.36	0	0.90
2	0.90	0.36	0	0.90
3	0.82	0.20	0	0.91
4	0.80	0.36	4.76	0.86
5	0.71	0.35	4.76	0.86
6	0.81	0.44	9.52	0.83
7	0.72	0.33	14.28	0.78
8	0.90	0.35	14.28	0.91
9	0.60	0.36	14.28	0.55
10	0.50	0.35	19.04	0.51
11	0.70	0.42	19.04	0.70
12	0.81	0.64	23.80	0.80
13	0.48	0.33	45.70	0.44
14	0.46	0.34	45.70	0.42
15	0.50	0.42	80.92	0.49
16	0.20	0.18	80.92	0.22
17	0.44	0.22	90.90	0.42
18	0.38	0.24	90.90	0.37

Post-test.

No. of Item	Mean	Variance	% not answered	Difficulty Index
1	1.80	0.36	0	0.90
2	1.80	0.36	0	0.90
3	2.00	0.00	0	1.00
4	2.00	0.00	0	1.00
5	1.80	0.36	0	0.90
6	1.80	0.36	0	0.90
7	1.40	0.84	0	0.70
8	1.60	0.64	0	0.80
9	2.00	0.00	0	1.00
10	1.40	0.84	0	0.70
11	1.80	0.36	0	0.90
12	1.80	0.36	0	0.90
13	5.50	24.25	0	0.55
14	5.00	25.00	0	0.50
15	4.00	4.00	0	0.40
16	2.00	8.50	0	0.20
17	20.60	15.84	0	0.89
18	4.00	4.00	0	0.40
19	9.80	16.14	0	0.56