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CHAPTER IV

PROCEDURE

4.0 INTRODUCTION

The preceding chapters have brought out the need and significance of a study of this kind. This section gives an overview of the different aspects of the study under specific heads namely the problem and objectives, the variables selected, hypotheses and methodology adopted.

4.1 THE PROBLEM

The study is on the 'Effects of different modes of pairing in programmed learning of mathematics on the performance of underachievers'.

Mixed-ability, teacher choice and 'student choice' were the three pairing modes selected for the study of their relative effects.

4.2 OBJECTIVES OF THE STUDY

The main objective of the study has been to establish the relative effectiveness of the three different modes of pairing students in programmed learning on the achievement in mathematics of the underachievers. Specifically the objectives have been
1) To develop a programmed learning booklet on a unit in mathematics suitable for the sample and validate the same.

2) To assess the effects of the three different pairing modes on the performance of the underachievers in the immediate post-test and the retention test later.

3) To study the effects on the achievement of the able peers paired with the underachievers in the experiment.

4) To test the significance of the differences between the effects of the three pairing modes on the performance of the underachievers in the post test as compared to the predicted score potentiality.

5) To study the attitudes of the underachievers and their partners in the three modes towards programmed learning in pairs.

6) To test the significance of the differences between the attitudes of the underachievers and their partners in the three modes.

4.3 VARIABLES SELECTED FOR THE STUDY

The dependent and independent variables considered for the study are discussed below:

Dependent Variables: 1) The main dependent variable is the performance of underachievers in mathematics. It refers to their achievement in mathematics as shown by the scores in the post experiment test and the delayed retention test on
the unit programmed (source material) 2) The attitude of underachievers towards the paired programmed learning technique.

**Independent Variables:** The three different pairing modes in programmed learning chosen for the study are the independent variables on which the performance of underachievers in mathematics in the tests after the treatments, depends. The attitude towards this approach also depends upon the pairing modes in programmed learning.

The other independent variables are some of the correlates of academic achievement that have been used to identify the underachievers. These independent variables studied, are:

1) **Achievement** in mathematics before the experiment.
2) **Socio-economic** status
3) **General intelligence**
4) **Class attendance**
5) **Study habits related to mathematics**
6) **Academic self-concept**
7) **Extraversion - Introversion**
8) **Participation** in extra curricular activities
9) **Motivation** and interest in mathematics
10) **Emotional and social adjustment**
4.4 HYPOTHESES:

Hartley (1973) reports that evidence for programmed learning in pairs leading to better learning and increased retention in comparison with individualised programmed learning is limited but contends that the approach is at least as effective as individual self-instruction as far as attainment in the subject matter is concerned (Hartley 1970, Amaria 1970).

Most experiments using relatively simple criteria for pairing students in programmed learning such as ability only or student choice only, have failed to find differences in post-test results at the secondary school level favouring one pairing method over another (Hartley, 1973). But Amaria (1970) has found the high-ability individuals in the randomly assigned pairs to be superior to similar students in self-chosen pairs and pupils of below average ability in the mixed-ability pairs to be better than those in the like-ability pairs. Lovatt and Broderick (1976) have found mixed-ability pairing advantageous especially for girls but regarding the attitude towards paired work in computer managed learning, some dissatisfaction with the rate of work among the high ability students has been noted. This supports the findings of Hartley and Hogarth (1971) also. Hogarth and Hartley (1973) have noted the own-choice pairs expressing favourable attitude than the teacher designated mixed ability pairs.
On the basis of the theoretical framework, the research findings in general, with special reference to the same mentioned above and in accordance with the objectives set up for the study, the following hypotheses have been formulated.

1. Programmed learning in pairs enables the underachievers in mathematics to improve their performance.

2. The 'mixed ability' pairing mode in programmed learning enables the underachievers in mathematics to improve their performance.

3. The 'teacher choice' pairing mode in programmed learning enables the underachievers in mathematics to improve their performance.

4. The 'student choice' pairing mode in programmed learning enables the underachievers in mathematics to improve their performance.

5. There is significant difference between the effects of the pairing modes in programmed learning namely (i) 'mixed ability' and 'teacher choice' (ii) 'mixed ability' and 'student choice' and (iii) 'teacher choice' and 'student choice' on the performance of underachievers in mathematics.

6. The post test performance of the underachievers in mathematics in all the three pairing modes in programmed learning does not significantly differ from the level predicted on the basis of their intelligence.

7. The post test performance of the able peers in all the three pairing modes in programmed learning does not significantly differ from the original level of performance in mathematics.
8. The underachievers express a significantly favourable attitude towards programmed learning in pairs.

9. There is significant difference between the attitudes of the underachievers in the three modes, towards programmed learning in pairs.

10. The able peers in the dyads express a significantly favourable attitude towards programmed learning in pairs.

11. There is significant difference between the attitudes of the able peers in the three modes, towards programmed learning in pairs.

4.3 METHODOLOGY

The investigation passed through several distinct stages. The programmed material was first developed and the underachievers were then identified. The underachievers were paired with able peers in three different modes. The treatment was given to the three groups of paired learners, after a pre-test. Post and retention tests were also conducted. The following paradigm (Figure 4.1) illustrates the procedure followed for the investigation.

4.5.1 TOOLS: The following tools were designed by the researcher apart from the specially prepared programmed learning material.

1. Test in mathematics

2. Self concept inventory

3. Interest (in mathematics) inventory

4. Participation in extra-curricular activities - a questionnaire.

The following tools were adapted from standardized ones.
THE STEPS IN THE INVESTIGATION

THE PARADIGM:

General Intelligence Test and Mathematics Achievement Test

Identifying Underachievers in Mathematics

Pairing of underachievers with able peers in different modes

Mixed Ability 'Weighted Scores'

Teacher Choice

Student Choice

Pre Test

Programmed Learning (using the PL Booklet prepared) in pairs by the 3 paired groups

Immediate Post Test and Attitude Measurement

Delayed Retention Test

Analysis of data for determining model effects on the performance of the Underachievers

Assessing the differential effects of the pairing modes

FIGURE 4.1
1) The general intelligence test designed by Boaz and Eliathamby (1955).

ii) Eysenck's Personality Inventory

iii) Bell's Adjustment Inventory - student form

iv) Kuppasamy's (1959) Socio-economic status scale

v) Study habits inventory - An adaptation of Gopal Rao's (1974) inventory

vi) Attitude scale - An adaptation of Lovatt and Broderick's (1976) 'Student opinionnaire' on paired learning in computer managed instruction.

The data relating to class attendance and other types of information about the students and schools were collected from school records and registers.

PROGRAMMED LEARNING BOOKLET  (APPENDIX A)

The selection of a unit for developing programmed learning material was done in consultation with a few experienced teachers of mathematics in the high schools. The unit selected was 'statistics' for standard IX as prescribed by Tamilnadu state education department. The syllabus is given in Appendix D.

The selected unit was divided into sub-units strictly following the logical treatment suggested in the syllabus prepared by the Directorate of School Education,
Government of Tamilnadu, in order to facilitate the paired programmed learning sessions in the classroom situations.

The unit was divided into five subunits. Sub unit I consisted of the following concepts: the introduction to statistics, the concepts, numerical data, constants, variables, discrete and continuous variables and the 'universe'.

Sub unit II was on organisation of data - tabulation, considering the range of data, deciding the size of the class intervals, using the tallies for the observations against the appropriate class intervals, finding the frequency of these observations in each class interval and forming the frequency distribution or table.

Sub unit III covered the second method of organisation of data, the graphical representation - Histogram and frequency polygon.

Sub unit IV consisted of the Arithmetic mean for ungrouped and grouped data; weighted arithmetic mean, Arithmetic mean for the frequency distribution, the long or direct, and short method.

Sub unit V was on median and mode for ungrouped data.
CONTENT ANALYSIS

The unit chosen was divided into five sub-units as explained above. The subject matter to be covered under each subunit was gathered and the factual information were organised. The general objectives of education—namely knowledge, understanding, application and skill were kept in view while selecting the content material for the unit.

TASK ANALYSIS

All the learning activities that the students would have to perform while they were exposed to the programmed material were listed and analysed. While doing the task analysis, the programmer, the investigator herself had in view the relevant behavioural outcomes. Suitable learning experiences and activities which would facilitate the achievement of identified behavioural outcomes were introduced in the programme. The learning outcomes are listed under 'Terminal behaviour'.

TARGET POPULATION

The students involved in the study were in the age group of 13-15 years in standard IX following TAMILNADU Secondary School syllabus in mathematics.
PREREQUISITES

The basic requisites for learning the particular unit 'statistics' through the programmed booklet are listed here under.

1) The students must have the basic knowledge of the fundamental operations in mathematics, simple mathematics related to life, ratio and proportion, averages etc.

2) Simple graphical representations, diagrams and interpretations.

TERMINAL BEHAVIOUR

The instructional objectives of teaching 'statistics' in standard IX include the following abilities

1) Collection of data 2) Presentation 3) Proper choice of class intervals 4) Tabulation 5) Graphic representation

6) Interpretation of statistical graphs 7) Calculating the arithmetic mean for grouped and ungrouped data 8) Calculating weighted arithmetic mean and hence finding out the percent in price rise 9) Location of median for ungrouped data 10) Locating mode for ungrouped data.

With these objectives as bases the terminal behaviours were listed out as follows: The student must be able to

1) distinguish between variable and constant in the given data and give examples for each
2) identify discrete and continuous variables and give examples for each

3) find the 'Universe' of the given data

4) find the range of the data given

5) decide upon the size of the 'interval' of the class

6) fit the data in the appropriate classes by tallying

7) find the frequencies for the different class intervals

8) form the frequency table for the raw data

9) draw the statistical graph 'Histogram' for the frequency table and explain it.

10) construct another statistical graph, 'frequency polygon' and explain it.

11) Calculate the arithmetic mean for the given ungrouped data

12) Calculate the arithmetic mean for the grouped data using the long/short methods and formulae

13) Compute the 'weighted' arithmetic mean for the data and apply the same in solving problems related to life.

14) locate the median for the given data

15) find the mode of the observations given and

16) Compute the most suitable or appropriate average according to the given data.

**FORMAT AND STYLE OF THE PROGRAMMED LEARNING BOOKLET (112 FRAMES)**

The style of presentation was basically linear and the correct answer to a frame was provided in the succeeding
frame which could be verified against the answers written in the record sheet by the student himself/herself.

FRAME STRUCTURE

In each frame the information was followed by an incomplete sentence or a very short answer type question or a problem based on the information. The student was supposed to respond suitably and check his response against the desired response given on the margin to the left of the succeeding frame. The correct answers were kept hidden by a sliding mask till the student responded and wrote down the answers.

The linear programmes generally adopt the completion type of question. In this study, the students were not only asked to construct their responses but also to calculate or simplify or identify the correct answer. Different types of questions were used to provide a variety of learning situations.

TRY-OUT (VALIDATION)

INDIVIDUAL TESTING

The purpose of this try-out was to see whether the material would be suitable for those for whom it was written.
A student from the target population with below average ability was selected and was asked to learn the programmed unit. The answers recorded by the student for each response situation were scrutinised at the end in order to make suitable alterations. The individual try-outs were repeated with five students, one at a time. This helped to remove ambiguous or poorly worded frames and modify the language, expression and teaching sequences for better comprehension by the learners.

The students made mistakes in answering frames on 'variables' and 'universe'; 'fitting the data in classes by marking the tallies' and the 'short method' in the calculation of the arithmetic mean and these frames were modified. The five sub-units were thus carefully tested and the second draft was made ready for small group testing.

**SMALL-GROUP TESTING**

The cyclostyled programme, the second draft was presented to a small, representative group of ten learners of standard IX of below average level in studies as opined by their maths teacher. The post-test already prepared and finalised by the programmer (investigator) was administered to this small group as pre-test to determine the extent of the students' knowledge in the area concerned. Instructions were given to this small group as to how to learn the programmed unit and respond. They were also asked to note down
the difficult and ambiguous areas in a frame or frame sequence. The time taken by every individual student for each sub-unit was noted and their performances in the criterion tests under the sub-units were recorded. At the completion of the programme, the post-test, the final criterion test was administered on all the students of this small group to measure the learning outcomes. The difficulties of these students were studied and the necessary modifications were made in the different subunits. The sequences explaining 'constants', 'variables' and 'universe' were again checked and modified. The logical sequence in presenting the 'Histogram' with classes of 'equal' and 'unequal' intervals was revised and so also the sequences for the 'Arithmetic mean' by the formula or direct method and the short methods. The revised draft was used in field testing.

FIELD-TESTING AND MASTER VALIDATION

The purpose of field testing is to assess whether the programme satisfactorily achieves its stated objectives when it is used with those for whom it was written. The programme which was tested at different stages of its development was tried using fifty representative learners.

A pre-pretest was given to find whether they had the pre-requisite behaviours. Then the major criterion test was administered as the pre-test in order to measure the learner's knowledge of what they were about to be taught. After this, printed copies of the programme were distributed among the
students. The programme was administered by the concerned teacher and not by the programmer since programmer's presence might create an 'experimental bias' in the results.

Instructions about working with the programme were given before the students started learning the programmed unit. It was made clear to the students that the purpose was to validate the programme and not to test the students. Time taken by each student in completing each sub-unit was recorded. All the programmed booklets and answer sheets were collected from the students. The post-test was then administered and the data on this test was used to calculate the gain ratios obtained from the pretest to the post-test.

The attitude scale was administered after the post-test.

Internal criteria

1) Error rate

\[
\text{Error rate} = \frac{\text{Total No. of errors}}{\text{Total No. of frames}} \times \frac{100}{\text{No. of individuals}}
\]

2) Programme density: (Cumulative)

\[
\text{Programme density} = \frac{\text{Total number of responses needed}}{\text{Total number of frames}}
\]

1) The error rate for the first draft = 2.90

2) The error rate of the second draft = 1.80

3) The error rate for the third draft = 0.85

4) The programme density = 1.57

5) The coefficient of internal consistency = .86
Sequence progression was satisfactory and time taken was 8 periods of 40 minutes duration each, spread over two weeks.

**EXTERNAL CRITERIA**

1) The 90/90 standard was maintained in the field testing.
2) All had significantly gained, \( g \geq .5 \) the gain ratio being calculated by the ratio of the actual gain to the possible gain (McGuigon and Peters, 1965)
3) The attitude towards the programme was favourable and significant \( p < .01 \).

**CRITERION TEST OR POST-TEST**

The programme consisted of five subunits and short criterion tests were given under each subunit; these served as the tools for formative evaluation to assess the learning progress of the students during the course. After completing the programme the students had to take a test measuring all the terminal behaviours specified. This was the major criterion test or the post-programme test or simply the post-test. The same test was used as the pre-test and the retention test.

The post test designed was administered to a representative group of 30 students who learnt the programme before field testing and the difficulty index and discriminating power of each item and the internal consistency of the test were estimated for finalising the test. Wherever necessary the
modifications were made to improve the items. The internal consistency was found to be .87 \( (p < .01) \) Time taken was two hours.

ACHIEVEMENT TEST IN MATHEMATICS

To assess the achievement level of IX standard students in mathematics an achievement test in mathematics suited to the standard of the students was constructed. It was basically on standard VIII mathematics syllabus prescribed for Tamilnadu secondary schools and also the introductory portions in mathematics specified for standard IX. This test was used for identifying the underachievers in mathematics.

As per the prepared blue print there were 40 objective type items relating to the objectives of knowledge understanding, application and skill. Eight teachers handling mathematics at the secondary level were consulted in the preparation of the blue print and the test.

VALIDITY AND RELIABILITY

The content validity was established by jury (three professors of mathematics, colleges of Education and five senior teachers of mathematics at the secondary level) opinion. Item analysis was made and the reliability of the finalised test was estimated using the method of rational equivalence. The reliability coefficient computed was .82. This provided an estimate of the internal consistency of the
test which indicated the high dependability of the scores. The reliability coefficient was found out by test-retest method also and it was found to be very high \( r = .852 \) \( N = 30 \). The students on an average took an hour to answer the test. This test was used as the mathematics ability test (MAT). The test is given in Appendix B.

**SELF-CONCEPT INVENTORY**

It was decided to study the self-concept of the students so that if it was found that it had significant influence on achievement in mathematics it could be considered as a factor for mixed ability pairing with appropriate weight-age assigned to it.

To assess the self-concept of students, the self-concept inventory developed by the investigator for her M.Ed. Thesis on 'Self-Concept of superior and underachieving girls in High Schools (Davies, 1975) was used. This 45 item inventory measured the self-concept of students in six areas:

1) Academic achievement 2) general feelings about self 3) feelings of adequacy 4) self-confidence 5) needs and goals and 6) general adjustment relating to self-concept.

This tool was compared with the standardized self-concept inventory, 'The way I feel about myself' designed by Piers and Harris (1964) which was on 'general self-concept'. The correlation coefficient was found to be .812. \( N = 40 \)
INTEREST (IN MATHEMATICS) - INVENTORY

Interest shown towards work or activity leads to success. Interest in studies is essential for academic success. Lack of interest in subjects could be one of the reasons for under-utilisation of the potential which results in underachievement. To study whether lack of interest in mathematics is one of the causes of underachievement in mathematics and if so to decide the weight to be allotted to this factor in mixed ability pairing, an interest inventory relating to the study of mathematics was designed by the investigator. The inventory is given in Appendix C.

The interest inventory consisted of two parts, the first with 10 items, each item having six options, which had to be ranked by students in the order of preferences and the second part, with 20 items (statements) relating to interest in mathematics against which the student had to rate himself on a five point scale. Care was taken to see that the preferences offered were over a wide field but within the field of experiences of the students and the responses were of such a type as to permit objective scoring and evaluation.
VALIDITY AND RELIABILITY

Validity of the inventory was established by the judgements of 10 experts in the fields of education and psychology, and the test-retest reliability coefficient was found to be .814 (p < .01; N = 30), the retest interval being three weeks.

QUESTIONNAIRE ON PARTICIPATION IN EXTRA CURRICULAR ACTIVITIES

Since it is probable that able students achieve low due to their active participation in various school programmes that are not purely academic it was decided to study the participation of underachievers and others in extra curricular activities. The questionnaire designed by an M.Ed student and the present investigator (as his guide and supervisor for his dissertation) to study the participation of students in extra curricular activities (Satagopan and Davies, 1979) was used. In the course of the preparation of the tool, two professors in the State Council of Educational research and training, three headmasters and five experienced teachers in charge of Co-curricular activities in schools were consulted. The Government of Tamilnadu has recently introduced the internal Assessment Scheme in high schools. Such of the activities which are given due importance in the internal assessment scheme were given special consideration in constructing the questionnaire.
The questionnaire included items relating to the physical and social activities which are co-curricular in nature. The face validity was established by jury opinion, the jury being a panel of five professors in Colleges of Education and five senior teachers at the secondary level.

**GENERAL INTELLIGENCE TEST (GIT)**

To identify the underachievers in mathematics for the study, a standardized intelligence test had to be used in addition to the achievement test in mathematics. The general intelligence test designed and validated by Boaz and Eliathamby (1955) (adapting the items from standardized intelligence tests, Boaz, 1964) in the department of psychology, University of Madras, was selected for this purpose. This is an individual test and included the categories (i) analogies, (ii) classification, (iii) reasoning, (iv) reading the table, (v) following directions under verbal items and (vi) completion tests (numbers and letters) (vii) classification, (viii) completion test (figures) (ix) matrices, (x) and cubes test under non-verbal items.

The Tamil version of this intelligence test was administered to a group of 30 students of standard IX to improve the translation and directions. The reliability coefficient was found by the split-half method and the application of the Spearman–Brown formula gave the value as .81, a significant (p < .01) index.
EXTRAVERSION - INTROVERSION

Eysenck’s Personality inventory was selected to estimate extraversion and introversion of underachievers in mathematics. The items in the inventory were translated in Tamil and administered to a representative sample to make the necessary changes in the form and expressions of each item in Tamil.

The experts’ (five professors of psychology in Colleges of Education) approval helped to establish the face validity of the 'Tamil' version of the tool and the test-retest reliability (.89) was high and significant, \( p < .01 \), the retest interval being two weeks.

EMOTIONAL AND SOCIAL ADJUSTMENT

For studying social and emotional adjustment of underachievers in mathematics the Tamil version of Bell’s Adjustment inventory was prepared. The items relating to social and emotional adjustment were considered and translated into Tamil in easy understandable language. Here it should be mentioned that certain items that were not culture free were modified to suit Indian, especially Tamilnadu setting. For example unfamiliar items such as 'Do you enjoy social gatherings just to be with people?' and 'Do you enjoy social dancing a great deal?', were modified to familiar concepts and themes, at the same time taking great care to see that they did not deviate
much from the original. Approval of experts, the same five professors of psychology in Colleges of Education was obtained before administering the tool to the group. The test-retest (with an interval of two weeks) reliability coefficient of 0.78 was significant at .01 level (n=40) for the Tamil version.

**STUDY - HABITS INVENTORY**

The Tamil version of Gopal Rao's (1974) study habits inventory with some changes in the items to suit mathematics study habits was chosen for the investigation. This inventory consisted of 40 items classified under five dimensions namely 1) Preparation and practice 2) effective reading 3) note taking 4) motivation and 5) general habits. The scoring was done on a three point scale for the responses yes, sometimes and no.

**VALIDITY AND RELIABILITY**

The face validity was established by a panel of experts; three professors of mathematics in colleges of education and five senior teachers of mathematics at the secondary level. The test retest (with an interval of two weeks) reliability coefficient was obtained as 0.76 which was significant (p < .01) (N = 30).

**SOCIO-ECONOMIC STATUS SCALE**

To determine whether socio-economic background correlates with underachievement significantly and if so to
of the socio-economic status scale developed and standardised by Kuppuswamy (1959) was used to study the socio-economic status of the students involved. Kuppuswamy developed the scale to measure Socio Economic Status (SES Scale) using three variables - Occupation, Education and Income. Each variable was broken into seven categories and weights were allotted to each of the categories.

**ATTITUDE TOWARDS PAIRED PROGRAMMED LEARNING**

The 'students opinion' questionnaire by Lovatt and Broderick (1976) designed to study the attitude of the like-ability and mixed-ability pairs towards computer-managed learning was translated into Tamil with some alterations. The adapted opinionnaire was used to study the attitude of the students towards the different modes of pairing. This attitude scale had just seven items on the quantity of work given, nature of work such as difficult or easy, interesting or not and on comparisons with the traditional approach. One of the items was on the preferences of working with a partner or all by oneself or sometimes the first and sometimes the other.

**SOURCES OF DATA: SCHOOL RECORDS AND REGISTERS**

**Attendance:** Percentage of attendance of the student for the academic year, '79-'80 was calculated from the information collected from the class attendance register.
ACADEMIC STANDARD OF THE SCHOOL

The percentage of passes in each school in the school final examination for the past three years was noted and the average was worked out. The average percentage of passes over a few years at the school final examination is generally treated as an index of the academic standard of an institution.

4.5.2 SAMPLE

The sample chosen for the study was from nine schools randomly selected from the population of secondary schools in the city of Madras and one school from Arkonam, a town about 70 Km away from Madras in a semi-urban area. All these schools follow the syllabus in Mathematics (at the secondary level) prescribed by the Directorate of School Education, Government of Tamilnadu. Out of the city schools there were boys' and girls' schools from three managements namely, the State Government, Corporation of Madras and Private bodies. The school in the semi-urban area was a coeducational school.

Random sampling procedure was adopted in selecting the schools and students. All the schools selected were Tamil medium schools. Adequate representation was given to each school in that, students from Standard IX were selected randomly and proportionately to the total strength in a parti-
cular school. The total sample of standard IX students from all these 10 schools was 1092, with 535 boys and 557 girls. The schools did not have very high or very low percentage of passes (30% to 70%) at the secondary school leaving certificate examination during the last three years. Such a large sample was chosen since the under-achievers in mathematics had to be identified for treatment of different modes of pairing in programmed learning and the sample within the sample had to be a sizeable one for conducting experiments.

All the tools mentioned above were administered to this large sample. The scores on the achievement test in mathematics and the general intelligence test were used to identify the underachievers. The scores on other tools were used to study if the variables had any significant influence on achievement in mathematics and for those variables which did have influence, weights were assigned, and considered for ability pairing.

IDENTIFICATION OF UNDER-ACHIEVERS IN MATHEMATICS

4.5.2.1 UNDERACHIEVERS

To identify the underachievers, the general intelligence test (GIT) and mathematics ability test (MAT) were administered to all the 1092 students. The raw scores obtained in GIT and MAT were expressed as percentage and the various statistical measures computed, appear in Table 4.1.
TABLE 4.1

Descriptive statistics of scores on intelligence and mathematical ability of the IX standard students.
(N = 1092)

<table>
<thead>
<tr>
<th>VARIABLES STUDIED</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>MOE</th>
<th>S.D</th>
<th>M.E.</th>
<th>SK</th>
<th>KU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematics Ability</td>
<td>45.65</td>
<td>45.40</td>
<td>44.89</td>
<td>14.42</td>
<td>10.36</td>
<td>0.052</td>
<td>0.270</td>
</tr>
<tr>
<td>Intelligence</td>
<td>60.22</td>
<td>61.00</td>
<td>62.57</td>
<td>16.73</td>
<td>12.22</td>
<td>0.13</td>
<td>0.267</td>
</tr>
</tbody>
</table>

Both the distributions closely approximate the normal. The two sets of scores expressed on the 'stanine' scale are shown in Table 4.2.

TABLE 4.2

The 'STANINE SCORES' on the general intelligence and Mathematics Tests.

<table>
<thead>
<tr>
<th>Stanine Scale</th>
<th>General Intelligence raw scores %</th>
<th>Mathematics raw scores %</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>89 and above</td>
<td>71 and above</td>
</tr>
<tr>
<td>8</td>
<td>91 - 88</td>
<td>64 - 70</td>
</tr>
<tr>
<td>7</td>
<td>73 - 80</td>
<td>56 - 63</td>
</tr>
<tr>
<td>6</td>
<td>64 - 72</td>
<td>49 - 55</td>
</tr>
<tr>
<td>5</td>
<td>56 - 63</td>
<td>42 - 48</td>
</tr>
<tr>
<td>4</td>
<td>48 - 55</td>
<td>35 - 41</td>
</tr>
<tr>
<td>3</td>
<td>39 - 47</td>
<td>28 - 34</td>
</tr>
<tr>
<td>2</td>
<td>31 - 38</td>
<td>20 - 27</td>
</tr>
<tr>
<td>1</td>
<td>below 31</td>
<td>below 20</td>
</tr>
</tbody>
</table>
tics was made. The distribution is shown in Table 4.4.

**Table 4.4**

Bivariate distribution of the students' predicted and actual stanine scores in mathematics.

<table>
<thead>
<tr>
<th>Predicted Stanines in Mathematics</th>
<th>UA</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>4</td>
<td>17</td>
</tr>
<tr>
<td>VIII</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td>VII</td>
<td>0</td>
<td>9</td>
</tr>
<tr>
<td>VI</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>V</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>IV</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>III</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>II</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td>I</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7</td>
<td>12</td>
<td>53</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>30</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>1092</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An underachiever is defined as one whose actual stanine score falls short by two of the predicted stanine score. Those students who fall below the line indicated across the entries in the table were considered to be the underachievers in mathematics. Four types of underachievers were identified.
1) The bright underachievers (9th stanines of the predicted scores and 7th stanines or below in the mathematics test) cases (9-7) (9-6) (9-5) (9-4) (9-3) (9-2) and (9-1).

2) Underachieving but at least passing (average) in mathematics (at least 5th stanine on actual achievement) (8-6) (8-5) and (7-5) cases.

3) Underachieving and failing in mathematics (4th stanine and below on actual achievement such as (8-4) (8-3) .... (7-4) (7-3) .... (6-4) (6-3) .... (5-3) (5-2) (5-1).

4) Underachieving, below average and failing miserably in mathematics (the 4-2, 4-1, and 3-1 stanines combinations).

In TYPES (2) and (3), (1) is excluded.

The total number of underachievers identified was 242, twenty two percent of the whole sample. For experimentation in this investigation, from TYPE (3) including the bright underachievers and those with actual stanines 4, 3 and 2, (the box shown in the underachievers region in Table 4, 4) the subsample was selected. From the 159 with the above specifications, 42 students with 'weighted scores' (explained at a latter page) on the correlates of achievement, below 100 were eliminated. Of the remaining 117, 12 students were absenting themselves for a session or two. The 105 underachievers who were regularly available for the experiment were finally considered. The 105 underachievers selected for the experiment were from six schools and involved in the three pairing modes with the able peers in learning the programmed unit in mathematics. The table below gives a picture of the sample drawn from the ten schools and the underachievers identified (UA) along with the overachievers (OA) and normal achievers (NA).
TABLE 4.5

DETAILED OF THE SAMPLE SELECTED

<table>
<thead>
<tr>
<th>S.No.</th>
<th>School</th>
<th>N</th>
<th>Boys</th>
<th>Girls</th>
<th>Under achievers</th>
<th>Over achievers</th>
<th>Normal achievers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Wesley Boys</td>
<td>MS-14</td>
<td>137</td>
<td>-</td>
<td>26</td>
<td>18</td>
<td>93</td>
</tr>
<tr>
<td>2.</td>
<td>NKT Girls</td>
<td>MS-5</td>
<td>147</td>
<td>-</td>
<td>147</td>
<td>36</td>
<td>80</td>
</tr>
<tr>
<td>3.</td>
<td>Corporation Boys</td>
<td>MS-5</td>
<td>40</td>
<td>-</td>
<td>40</td>
<td>3</td>
<td>29</td>
</tr>
<tr>
<td>4.</td>
<td>Corporation Girls</td>
<td>MS-5</td>
<td>40</td>
<td>-</td>
<td>40</td>
<td>2</td>
<td>25</td>
</tr>
<tr>
<td>5.</td>
<td>Lady Wellington</td>
<td>MS-5</td>
<td>137</td>
<td>-</td>
<td>137</td>
<td>35</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Model School Boys</td>
<td>MS-15</td>
<td>100</td>
<td>-</td>
<td>16</td>
<td>27</td>
<td>57</td>
</tr>
<tr>
<td>7.</td>
<td>Corporation Girls</td>
<td>MS-15</td>
<td>118</td>
<td>-</td>
<td>118</td>
<td>23</td>
<td>76</td>
</tr>
<tr>
<td>8.</td>
<td>Corporation Boys</td>
<td>MS-14</td>
<td>130</td>
<td>-</td>
<td>41</td>
<td>28</td>
<td>61</td>
</tr>
<tr>
<td>9.</td>
<td>Govt. Boys and</td>
<td>MS-19</td>
<td>80</td>
<td>40</td>
<td>40</td>
<td>5</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td></td>
<td></td>
<td>(9+11)</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>St. Andrew's Boys</td>
<td>Arko-</td>
<td>163</td>
<td>88</td>
<td>75</td>
<td>42</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>and Girls</td>
<td>nam</td>
<td></td>
<td>(22+20)</td>
<td>40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WEIGHTING THE CORRELATES OF ACHIEVEMENT IN MATHEMATICS

Some of the possible causes of underachievement as reported in the related studies such as attendance, study habits in mathematics, interest in the subject, socio-economic background, social and emotional adjustment, self-concept, extraversion-introversion and participation in school activities were measured by administering the tools described.
The scores on different variables obtained by the underachievers and normal achievers were analysed and tested for significant differences, the results of which are presented in the following Table.

**TABLE 4.6**

Details of the significance of the differences between the scores on correlates of achievement of the normal and underachievers in mathematics.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Factors</th>
<th>Groups</th>
<th>M</th>
<th>S.D. C.R.</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NA</td>
<td>633</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>242</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(a) SES</td>
<td>NA</td>
<td>13.58</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>12.07</td>
<td>4.92 4.035</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td>(b) Edn. of parents</td>
<td>NA</td>
<td>3.84</td>
<td>1.34 6.32</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>3.20</td>
<td>1.20</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Attendance</td>
<td>NA</td>
<td>88.30</td>
<td>8.70 8.59</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>84.00</td>
<td>5.63</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Study habits</td>
<td>NA</td>
<td>95.75</td>
<td>12.00 2.40</td>
<td>.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>93.70</td>
<td>11.00</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Self-concept</td>
<td>NA</td>
<td>60.40</td>
<td>12.15 9.02</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>52.45</td>
<td>11.88</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Interest in Maths</td>
<td>NA</td>
<td>74.20</td>
<td>10.60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>69.33</td>
<td>11.53 5.71</td>
<td>.01</td>
</tr>
<tr>
<td>6</td>
<td>Extra-version</td>
<td>NA</td>
<td>13.76</td>
<td>6.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>17.68</td>
<td>6.00 8.35</td>
<td>.01</td>
</tr>
<tr>
<td>7</td>
<td>Social and Emotional adjustment problems</td>
<td>NA</td>
<td>26.30</td>
<td>13.18 6.61</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>34.80</td>
<td>15.64</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Participation in Extra. Curr. activities</td>
<td>NA</td>
<td>55.20</td>
<td>9.11 7.57</td>
<td>.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UA</td>
<td>63.00</td>
<td>15.00</td>
<td></td>
</tr>
</tbody>
</table>
In the factors studied the underachievers significantly differed from the normal achievers. The underachievers were from comparatively low socio-economic group and educational background. Their class attendance and study habits were poorer than those of the other group. They had more negative self concepts and lower motivation. They were too extraverted, had more social and adjustment problems, spent more time and showed more interest in participating in extracurricular activities when compared to the normal achievers.

These factors were hence considered for 'ability' pairing and the regression analysis was conducted for assigning 'weights' to the significant contributors among these to achievement in mathematics.

**WEIGHTED SCORE:** To find the 'weights' for the factors, as a first step the regression analysis was made. The results (scores) on the ten variables namely 1) mathematics achievement 2) general intelligence 3) motivation and interest in mathematics 4) selfconcept, 5) extraversion 6) social and emotional adjustment problems 7) socio-economic status 8) study habits in mathematics 9) class attendance and 10) participation in extracurricular activities were computerized and the regression equation was obtained for the dependent variable namely achievement in mathematics with the other nine variables as independent ones as:

\[ Y = 1.5 + .61 x_1 + .51 x_2 + .379 x_3 + 1.00 x_4 - .125 x_5 + .366 x_6 + .430 x_7 + .083 x_8 - 2.387 x_9 \]
of the regression coefficients only five were significant namely those relating to intelligence (.61) motivation and interest in mathematics (.51) self-concept (.38), adjustment problems (-.13) and study habits in mathematics (.43). The other variables were not considered for the purpose of ability pairing. The corresponding zero order correlations \( r_1, r_2, r_3, r_4, r_5 \) were .63, .24, .20, -.21 and .30. Using the standard deviations and regression coefficients the beta (\( \beta \)) weights were obtained as .51, .42, .29, -.14, and .31.

The multiple \( R^2 \) was found to be .6025 using the betas and correlation coefficients. \( R^2 \) gives the proportion of the variance of the criterion measure namely achievement in mathematics attributable to the joint action of the five independent variables (1) intelligence 2) motivation and interest in mathematics 3) self-concept 4) adjustment and 5) study habits relating to mathematics. Accordingly, 60.25\% of whatever makes the students differ in achievement in mathematics can be attributed to differences in general intelligence, study habits, individual's self concept, interest and motivation and social and emotional adjustment. The remaining of the variance of achievement in mathematics may be attributed to factors dropped and some other correlates not measured in this study.

**FACTOR ANALYSIS**

The ten sets of scores on the variables obtained by the underachievers were factor analysed to determine the basic
traits or other sources of variance operating (Fruchter, 1967). Four factors (dimensions) were identified: THE FIRST one with high loadings on study habits, adjustment and interest in mathematics was identified as 'Personal adjustment and moti-vated study techniques'; THE SECOND factor with high loadings on achievement in mathematics and general intelligence was identified as 'Mathematical ability'; THE THIRD one with moderate loadings on extraversion and participation in activities was named as 'Extraversion and purposeful social participation'; and THE FOURTH factor was school attendance and Self concept. These dimensions serve to account mathematically for observed individual differences namely underachievement in mathematics.

Sub.

SAMPLE: For the experiment the sample selected was 105 under-achievers (with actual stanines 4, 3 or 2) among the 242 identi-fied. These 105 underachievers were distributed in five schools in Madras city (Urban area) and one school in Arkonam, in the semi-urban area. Among the five schools in city, one was co-educational but with separate sections for boys and girls run by the state government. Two schools, (one Boys' and one Girls') were under private management and two, (one boys' and one girls') schools were managed by the city Corporation. In the five schools in city six groups of underachievers emerged.

The town school being a coeducational institution (actually one girls' school and one boys' school under the same private management rolled in one) one group of underachieving
boys and another group of underachieving girls were available for conducting the experiment. With these two groups there were totally eight groups involved for the treatment. The school-wise break up of the underachievers is given in Table 4.7.

**Table 4.7**

Table showing the schoolwise distribution of underachievers selected for the experiment.

<table>
<thead>
<tr>
<th>Groups of UA</th>
<th>School</th>
<th>Locality</th>
<th>Size (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Corporation, Boys</td>
<td>Urban</td>
<td>16</td>
</tr>
<tr>
<td>S2</td>
<td>Corporation, Girls</td>
<td>Urban</td>
<td>15</td>
</tr>
<tr>
<td>S3</td>
<td>Government, Boys</td>
<td>Urban</td>
<td>9</td>
</tr>
<tr>
<td>S4</td>
<td>Government, Girls</td>
<td>Urban</td>
<td>11</td>
</tr>
<tr>
<td>S5</td>
<td>Private, Boys</td>
<td>Urban</td>
<td>14</td>
</tr>
<tr>
<td>S6</td>
<td>Private, Girls</td>
<td>Urban</td>
<td>10</td>
</tr>
<tr>
<td>S7</td>
<td>Private, Boys</td>
<td>Semi Urban</td>
<td>15</td>
</tr>
<tr>
<td>S8</td>
<td>Private, Girls</td>
<td>Semi Urban</td>
<td>15</td>
</tr>
</tbody>
</table>

There were 75 underachievers from the urban and 30 from the semi-urban schools considered for the experimental treatment namely programmed learning in pairs.

### 4.5.3 Pairing Modes

On the assumption that programmed learning by students in pairs is advantageous than the individual programmed
learning (Hartley and others (1973) a three groups experimental design was planned without any control group, to study the differential effects of three pairing modes.

**MIXED - ABILITYPAIRING**

The first group had pairs containing an under-achiever in mathematics and an able peer who got high 'weighted score' on the correlates of achievement in mathematics including personality measures or the factors studied and found significantly influencing achievement. The beta weights obtained for the variables intelligence, motivation and interest in mathematics, study habits, self-concept and adjustment problems which were found to influence achievement in mathematics significantly were used in finding the weighted score for the under-achievers in mathematics and the able pairs in the same class.

The weighted ability score for each student in the class was arrived at using the mathematical model

\[ W_a = A_0 + .51A_1 + .42A_2 + .31A_3 + .29A_4 - .14A_5 \]

Where \( W_a \) stands for weighted ability score, \( A_0 \), score in the MM; \( A_1 \) score in the IQ; \( A_2 \), score on motivation and interest; \( A_3 \), score on study habits; \( A_4 \), score on self-concept and \( A_5 \) score on adjustment problems. For example an underachiever with raw scores 31, 60, 58, 48, 60 and 36 respectively gets the weighted ability score as

\[ W_a = 31 + .51 \times 60 + .42 \times 58 + .31 \times 48 + .29 \times 60 - .14 \times 36 = 113.2 \]
PAIRING MODES

I. MIXED ABILITY PAIRS:
   STUDENTS IN RANK ORDER OF THE WEIGHTED SCORES

   \[ \triangle 1 \rightarrow \triangle 2 \rightarrow \triangle 3 \rightarrow \triangle 4 \rightarrow \triangle 5 \rightarrow \circ 1 \rightarrow \circ 2 \rightarrow \circ 3 \rightarrow \circ 4 \rightarrow \circ 5 \]

   (A) \hspace{1cm} (UA)

II. TEACHER'S CHOICE

III. STUDENTS' CHOICE

PROGRAMMED LEARNING IN PAIRS

\[ \triangle \rightarrow \circ \hspace{1cm} \triangle \rightarrow \circ \hspace{1cm} \triangle \rightarrow \circ \hspace{1cm} \triangle \rightarrow \circ \hspace{1cm} \triangle \rightarrow \circ \hspace{1cm} \triangle \rightarrow \circ \]

\( \triangle \) - ABLE PEERS \hspace{1cm} \( \circ \) - UNDER ACHIEVERS

FIGURE 4.2
and an able peer with raw scores 78, 85, 72, 90, 90, 33 gets
the weighted ability score as

\[ W_a = 78 + 0.51 \times 85 + 0.42 \times 72 + 0.31 \times 90 + 0.29 \times 90 - 0.14 \times 33 \]

\[ = 200.97 \]

The able peers and the underachievers were
arranged in the rank order of their weighted scores in two
groups. The first rank holder in the able group (A) was
paired with the first rank holder in the underachievers group
(UA); the second in (A) with the second in (UA) and so on.
(See figure 4.2 on 5 pairs). The pairing based on the 'weighted
scores' or this 'rank order' pairing is referred to as the
'mixed ability' pairing in this study.

PAIRING BASED ON TEACHER'S CHOICE

In the second group the underachiever was paired
with an able peer (a high achiever) by the teacher handling
mathematics for the group. The teacher knows his students
better personally and can 'pair' them up suitably considering
the variabilities and characteristics of the students involved
and deciding which high achieving student would work better
with which underachiever. From among the two groups of under-
achievers and able peers the dyads were formed choosing one
from each group by the teacher.

PAIRING BASED ON STUDENTS' CHOICE

The third group consisted of dyads where the
underachievers themselves chose the partners from among the
able peers who willingly accepted the offer.

All the three pairing modes as explained above are mixed 'ability' modes but in this report, the 'rank order' pairing mode based on the 'weighted score' is referred to as 'mixed-ability' mode, others being 'teacher choice' and 'student choice' modes.

4.5.4 DESIGN OF THE EXPERIMENT

The underachievers and able peers were paired in the three different modes at random. The underachievers were assigned at random to the three groups and they were paired with the able peers according to the three modes.

TABLE 4.8

<table>
<thead>
<tr>
<th>Groups</th>
<th>Management</th>
<th>Locality</th>
<th>Sex</th>
<th>Pairing Mode</th>
<th>JA Selected for Expt.</th>
<th>Able peer selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>S_1</td>
<td>Corporation</td>
<td>Urban</td>
<td>Boys</td>
<td>Mixed -</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>S_2</td>
<td>Corporation</td>
<td></td>
<td>Girls</td>
<td>Ability</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>S_3</td>
<td>Government</td>
<td>Urban</td>
<td>Boys</td>
<td>Teacher</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>S_4</td>
<td>Government</td>
<td></td>
<td>Girls</td>
<td>Choice</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>S_5</td>
<td>Private</td>
<td>Urban</td>
<td>Boys</td>
<td>Student</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>S_6</td>
<td>Private</td>
<td></td>
<td>Girls</td>
<td>Choice</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>S_7</td>
<td>Private</td>
<td>Semi-Urban</td>
<td>Boys</td>
<td>All three</td>
<td>15</td>
<td>(5+5+5)</td>
</tr>
<tr>
<td>S_8</td>
<td>Private</td>
<td>Urban</td>
<td>Girls</td>
<td>Modes</td>
<td>15</td>
<td>(5+5+5)</td>
</tr>
</tbody>
</table>
Pre-Pretest: The pre-pretest was given to the underachievers and their partners to ascertain whether they were eligible to take up the programmed learning course. This was a very simple and easy test based on the prerequisites for learning the programmed material. All the underachievers and their partners were qualified for taking the 'programme'.

Pre-test: The main criterion test or the post-test constructed already was given to all involved as the pre-test before starting the learning of the programme in pairs.

PROGRAMMED LEARNING BY THE STUDENTS IN PAIRS (THE DYADIC PROGRAMMED LEARNING)

The underachievers and the able peers or high achievers in their class paired with them learnt the programmed unit, each one using the programmed booklet. In the three experimental groups the underachievers were helped by the 'high ability peer partners, the able peers chosen by their teacher and the able peer partners of their own choice according to the mode of grouping. These peers also checked the progress of the underachievers from frame to frame getting them to respond in appropriate ways. The investigator evaluated the performance at the end of all five sub-units, primarily to assess the progress of the underachievers during the process. At the end of each short criterion test on a subunit, the pairs discussed the points before they took up the subsequent sub-unit.
In all pairing modes the students were encouraged by the investigator to do their very best while learning frame after frame, writing the short criterion tests and work cooperatively so that they could do better in the final criterion test since all of them had the potential to perform well in any mathematics test.

With each group irrespective of the pairing mode, the following plan was adopted (Figure 4.3).

First day: Forenoon: The underachievers and their able partners were administered the pre-test. Afternoon: The final criterion test (post test) on the programmed unit was given as the pre-test to all involved.

Second day: The lesson on fundamental statistical concepts - stage one followed by the short criterion test one.

Third day: Dyadic discussion on test performance; lesson on organisation of statistical data - Tabulation - stage two.

Fourth day: Same lesson - stage two continued, followed by the second short criterion test.

Fifth day: Discussion in pairs on the test performance - lesson on organisation of statistical data, Graphical representation - stage three, followed by the short criterion test - three.

Sixth day: Discussion in pairs on the test performance - Lesson on Arithmetic mean and weighted arithmetic mean - stage four.

Seventh day: Same lesson - stage four continued, followed by the short criterion test - four.
THE PLAN OF THE EXPERIMENT

1ST DAY
- PRE-PRE-TEST

2ND DAY
- PAIRED PROGRAMMED LEARNING, LESSON - STAGE I: FUNDAMENTAL STATISTICAL CONCEPTS
- FEEDBACK ON CT₁ PERFORMANCE AND DYADIC DISCUSSION
- PAIRED PROGRAMMED LEARNING, LESSON - STAGE II: ORGANISATION OF STATISTICAL DATA - TABULATION
- PAIRED PROGRAMMED LEARNING, STAGE I: TABULATION - CONTINUED

3RD DAY
- FEEDBACK ON CT₂ PERFORMANCE AND DYADIC DISCUSSION
- PAIRED PROGRAMMED LEARNING, LESSON - STAGE III: GRAPHICAL REPRESENTATION
- FEEDBACK ON CT₁ PERFORMANCE AND DYADIC DISCUSSION
- PAIRED PROGRAMMED LEARNING, LESSON - STAGE IV: ARITHMETIC MEAN AND WEIGHTED A.M.
- PAIRED PROGRAMMED LEARNING, STAGE IV: A.M. CONTINUED

4TH DAY
- FEEDBACK ON CT₃ PERFORMANCE AND DYADIC DISCUSSION
- PAIRED PROGRAMMED LEARNING, LESSON - STAGE V: MEDIAN AND MODE
- FEEDBACK ON CT₂ PERFORMANCE AND DYADIC DISCUSSION
- REVIEW OF THE UNIT IN PAIRS-PER ASSISTANCE AS PREPARATION FOR THE FINAL CRITERION TEST, THE POST-TEST

5TH DAY
- POST-TEST FOR UNDER-ACHIEVERS AND THE ABLE PEEPS PAIRED WITH THEM IN THREE DIFFERENT MODES

LAST DAY
- 3 WEEKS CAP
- RETENTION TEST

FIGURE 4.3
Eighth day: Dyadic discussion on test performance. Lesson on median and mode, stage five, followed by the short criterion test - five.

Ninth day: Discussion of the test performance and revision. Review of the whole unit by the members in dyads, discussion, peer tutoring or assistance as preparation for the final criterion test, the post-test.

Tenth day: The post-test was conducted to the underachievers and the able peers and the attitude scale was administered after the test. With that the first phase came to an end. The dyads worked with the programmed learning booklet simultaneously and so there was no possibility of groups consulting each other. These ten sessions were spread out for two weeks in each school, of course, with some difficulty in adjusting to the requirements of experimentation at the same time not affecting the regular work much in the schools.

After three weeks the post test was administered to the underachievers in mathematics and the able peers paired with them without prior notice. The purpose was to measure the delayed retention of the learner's gain. This was the second phase in the experiment.

The investigator was the initiator and control of the sessions with the teachers in charge assisting her with the arrangements and administration of the tests. Both the self-learning and dyadic interaction were encouraged. The learners were given score sheets to record their answers to
frames for mutual checking and also for answering the short criterion tests on the sub-units. The investigator gave directions to value the scripts with the 'pair' exchanging the answer sheets. The corrected scripts were taken up before the next lesson for dyadic discussion and understanding or peer tutoring if necessary. On the whole the dyadic approach in programmed learning provided for self-pacing as well as one-on-one paired learning. The scores on pre and post programme learning tests, the retention test and attitude inventory were given appropriate statistical treatment. Only the total scores indicating achievement in general were analysed and not the part scores relating to knowledge, understanding, application and skill aspects.

4.5.5 STATISTICS

The descriptive statistical measures such as the mean and standard deviation for the pre, post and retention test scores and scores on the independent variables were calculated. Correlation coefficients between the pre and post test scores and post and retention test scores were also computed.

STANINES: The scores on mathematics achievement test and the predicted scores in mathematics based on intelligence were expressed on the stanine scale to identify the underachievers.

REGRESSION ANALYSIS: The correlations between the different variables, the factors relating to underachievement were calculated and beta weights were found out using multivariate regression analysis. These measures were used in finding the 'weighted scores'
for the students to be teamed on mixed ability (rank order) pairing.

**FACTOR ANALYSIS:** Even though the objective was not to study the causes of underachievement in mathematics or the characteristics of underachievers, since such tests on some correlates of achievement were used for fixing weights and then arriving at weighted scores for mixed ability, 'rank order' pairing, the scores on MAT, CIT and the eight independent variables were factor analysed to ascertain their factorial composition (Fruchter, 1967).

**ANNOVA AND ANCOVA**

The post-test scores and gain ratios were analysed using the analysis of variance (one way and two-way) and covariance analysis techniques in the 'differential' treatment of the data and the F-test was applied to test the significance of the difference between the effects of the three pairing modes. (Garrett, 1973; Guilford, 1973).

Bartlett's test of homogeneity of variance was applied while ANOVA was used, assuming normality of achievement in mathematics in the population of all students of Standard IX following the common syllabus, (Dubois 1965).

**TESTS OF SIGNIFICANCE**

The 't' test was used to study the significance of the difference between the underachievers and normal achievers in the eight independent variables (factors) other than general
intelligence. When F-value was found significant, the 't' test was applied to study the significance of the difference between the effects of the pairing modes taken two by two. To study the significance of the attitudinal differences, chisquare test was used.

**THE GAIN RATIO**

The pre, post and retention test scores were used to find the means and the gain ratio for each underachiever and the three paired groups. McGuigan and Petters (1965) formula for gain ratio namely gain ratio \((g) = \frac{\text{Actual gain}}{\text{Possible gain}}\)

**MATRIX ANALYSIS:** The method suggested by Brown, Cherrington and Cohen (1975) to construct a matrix to identify the student's position before and after a 'course' was used to study the shift of the underachiever in the post test performance from the predicted level and that of their partners from their original level of performance in mathematics. To find the significance of shift 't' test was applied.

### 4.6 CONCLUSION

This chapter gives a brief description of the rese design formulated for the current investigation which has as its main objective, a study of the differential effects of the three pairing modes in programmed learning on the achievement of underachievers in mathematics. A sample of 105 underachievers out of
the 242 underachievers identified from 1092 students of standard IX formed the subject of the paired programmed learning experiment along with the 105 able peers paired with them as their partners in the dyads in three different ways. A series of eleven hypotheses formulated in this regard would form the basis of analysis and interpretation of data pertaining to the investigation.

The next chapter is devoted to analysis of data, discussion of results and testing of hypotheses.