CHAPTER - IV
METHOD AND PROCEDURE

4.1 Sample Design:

The main focus of the present study was to ascertain the effect of new instructional methods in teaching mathematics at the secondary level in class IX and class X in Arunachal Pradesh in the N.E. region, in attaining better achievement in the subject. The difference between rural and urban samples with different methods of teaching were taken into the sample design. The basic design of the sample was 'Pretest - Post test' design.

The sample of the study consisted of 480 pupils (240 urban pupils and 240 rural pupils) of class IX and X, boys and girls purposely selected from four higher secondary/secondary schools (2 from urban and 2 from rural). The table 4.1 gives the description of the sample.

Table 4.1: Sample design

<table>
<thead>
<tr>
<th>Institution</th>
<th>Area</th>
<th>No. of Teacher</th>
<th>No. of Pupils</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Engaged Class- IX</td>
<td>Class- X</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control group</td>
<td>Expt. group</td>
<td>Control group</td>
</tr>
<tr>
<td>A. School</td>
<td>Urban</td>
<td>1</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>B. School</td>
<td>Urban</td>
<td>1</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>C. School</td>
<td>Rural</td>
<td>1</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>D. School</td>
<td>Rural</td>
<td>1</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
</tbody>
</table>
The medium of instruction of the institutions selected was English and followed same syllabus and course under C.B.S.E. Two groups from Class IX and Class X from each selected schools were selected by the process of randomisation, one is experimental group and the other is control. The number of students in each groups was mentioned the table 4.1. One trained mathematics teacher was engaged in each school to teach mathematics of the control group by the traditional method. The research scholar himself taught the experimental groups using new instructional methods.

The instructional methods for this study were:
(1) Programmed Instruction method
(2) Integrated Programme learning method.
(3) Objective based teaching method.

The topics chosen for this experiment were:
(1) The sample equation from algebra for class IX.
(2) The quadratic equation for class X.

The investigator first studied the content of the curriculum of mathematics and collected informations about the course contents covered by the mathematics teachers who taught mathematics in class IX and X and methods used in teaching the subject. He held discussion with all the mathematics teachers of each institution and took note of their reactions and suggestions regarding teaching mathematics in class room.

According to their opinions, (1) The student's attitude towards mathematics was very poor due to the relaxation given by C.B.S.E. and not received proper instructionns by the teachers in the primary and middle level of school education.
2. The computing and reasoning ability, comprehension towards mathematical terms, and vocabulary of majority of the students were very poor.

3. The retentive power of students are very poor due to the lack of frequent revision and practices as well as in the burden of syllabus and socio-economic conditions.

4. In class IX and X, the teachers were facing difficulties to give idea about function, absolute value etc. as per new syllabus due to the lack of teacher's orientation programme and reference books.

5. In the lower classes, the courses of mathematics were not fully covered and hence it effected badly in learning in the secondary level.

6. There was lack of competitive spirit among school going children.

7. There was lack of guidance and administration of parents at home due to illiteracy.

8. There was frequent upgradation of middle schools to secondary school without eligible teachers and proper facilities.

4.2. TEACHING STRATEGY:

With due permission from the Head of the institutions, the investigator started planning of class teaching as per sample design and the schedule of time table given below.

The time table for teaching the experimental and control groups of class IX and class X was as follows.
<table>
<thead>
<tr>
<th>Duration</th>
<th>Area</th>
<th>School</th>
<th>Class</th>
<th>Group</th>
<th>Topic</th>
<th>Methods</th>
<th>Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 weeks</td>
<td>URBAN</td>
<td>A</td>
<td>IX</td>
<td>Control Exp.</td>
<td>S.Equation</td>
<td>Tradition</td>
<td>P.I. IPI</td>
</tr>
<tr>
<td>3 weeks</td>
<td>RURAL</td>
<td>B</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
</tr>
<tr>
<td>3 weeks</td>
<td>URBAN</td>
<td>C</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
</tr>
<tr>
<td>3 weeks</td>
<td>RURAL</td>
<td>D</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
<td>Do</td>
</tr>
</tbody>
</table>

The following teaching aids were used in class teaching: Less: on Notes of topics (i) Programmed Instruction frames - one in simple equation and one in Quadratic equation (appendices $A$ and $B$).

(ii) Two Integrated Programmed Instruction frames - one in simple equation and one in Quadratic equation (appendices $A$ and $B$).

(iii) Two objective Based Teaching lesson notes (appendices $A$ and $B$).

The detail description of new methods were given below along with the validation of Programmed Instruction frames.

(1) Programmed Instruction Methods :-

The programme instruction (P.I.) is an instructional technique designed to suit the teaching learning situations. It differs from the common instructional programme in some specific characteristics. During 1950 the programmed instructions were put into use simultaneously. The principles of characteristics were vigorous applied and practice was based on experimental evidences. The application of psychology to human learning, the invention of teaching machine and the development computer science were greatly responsible for the birth of this instructional technique called Programmed Instruction.
Programmed instruction implies systematic arrangement of instruction events. It requires analysis. Only after analysis, the events can be sequenced in some predetermined order. The analysis of instructionable task was attempted even by ancient Greek educators. The catechetical tradition of the middle ages followed systematic arrangement of instruction. The technique was used in religious instruction. Even today it is used in missionary schools. This technique is a question-answer sequence developed in a planned paradigm (model).

Programmed instruction follows certain principles. Six principles are considered to be the basic principles. They are objectives, specification, small steps, active over response, immediate feedback, self-pacing and student-testing of these six objectives, specification, student testing and self pacing are considered mandatory.

There are three different style of programmes—Linear, branching and auto programme. The linear style of programme is developed using all the six principles of programming developed by 'Skinner'. In general P.I. means linear programmed instruction. Here programmes have made some modifications using 'Lock Step' sequence. Here students are moving steps by steps and at each step he is locked (detained) till he emits correct response. Students have also proved that a variety of subject can be taught to a variety of students through linear programming. In this study, the linear programming style of frames was use.

**Integrated Programmed Instruction**:

Cowder, an American programmer, first developed the idea of branching programming which now a days called Integrated
programmed instruction. According to Cowder, the information need not necessarily be given in small steps. He believed that constructed responses were not the only way at responding to test items. He thought that all these could be done by a new style of programming called it branching programming. Here more small steps are combined together. The branching programmes have comparatively large step size. They present paragraphs of more informations. The test item is a multiple choice response. If he is correct in his choice, he is directed to the frame where the next information in the sequence is presented. If he makes a mistake, he is directed to a frame where remedial steps are given. The frame arrangement in branching programming is called scrambled arrangement. The Linear moves this way or that way as if climbing over mountains, because the frames in branching style are not in a straight line sequence.

Validation of Program frames.

Before using the programmed instruction frames, the validation of programme is to be tested. For this the following steps are to be done.

(1) The programme is first tried to a small group of the sample of the experiment.

(2) A pretest will be given to the selected group. Their response will be analysed. The pretest scores for each student will be calculated.

(3) The student group will be given the main programme. They will give their response in the programme. The response will be analysed and the errors the students made in each items, will be calculated after the learner the programme.
(2) The post test is given, the post test score of each student is also calculated.

(3) An aptitude test will be given to find out student attitude towards the programme. The time taken by each to complete the programme will be noted.

The difference between the post test score and pretest score show the gain score, then the error rate and the programme density will be calculated.

**The scheme of analysis**

<table>
<thead>
<tr>
<th>Serial number of frames</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sl.No. 1 2 3 4 5 6 7 8 9 ............19 20</td>
</tr>
<tr>
<td>of 1 X X X R</td>
</tr>
<tr>
<td>S 2</td>
</tr>
<tr>
<td>T 3 X</td>
</tr>
<tr>
<td>U 4 X X X X R</td>
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<tr>
<td>D</td>
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<td>E</td>
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<tr>
<td>N</td>
</tr>
<tr>
<td>T 8 X X X X X</td>
</tr>
<tr>
<td>S</td>
</tr>
</tbody>
</table>

'R = Unexpected response
X = Wrong response

1. Error Rate = Total number of errors
   (Total number of test items) x Total number of students

2. Programme density = No of response required
   No of frames

Gain score = difference between pretest and post test score.
were analysed and the errors made by the students in each items were calculated. After the learner learnt the programme the post test was given. The post test score of each student was also calculated. Then attitude test was administered to know the attitude of students towards the programme. After the completion of the aforesaid the error analysis was carried out.

(1) Error analysis of programme frames for the topic of simple equation.

(2) Error analysis of programme frames for the topic of quadratic equation.

The post test responses were studied. Each student's errors were analysed and entered into a table as shown below.

**VALIDATION OF PROGRAMMED FRAMES OF SIMPLE EQUATION FOR CLASS -IX**

### 4.3 ERROR ANALYSIS :-

<table>
<thead>
<tr>
<th>Serial No. of pupils</th>
<th>Pretest scores</th>
<th>Post test scores</th>
<th>Gain in scores</th>
<th>Errors in post test</th>
<th>Total Time in post test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
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<td>10</td>
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<td>3</td>
<td>10</td>
<td>19</td>
<td>9</td>
<td>11</td>
<td>29</td>
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<tr>
<td>4</td>
<td>9</td>
<td>16</td>
<td>7</td>
<td>14</td>
<td>25</td>
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<td>5</td>
<td>12</td>
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<td>8</td>
<td>10</td>
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<tr>
<td>6</td>
<td>15</td>
<td>23</td>
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<td>7</td>
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<td>15</td>
<td>29</td>
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<tr>
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<td>8</td>
<td>16</td>
<td>8</td>
<td>14</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>11</td>
<td>20</td>
<td>9</td>
<td>10</td>
<td>26</td>
</tr>
</tbody>
</table>

| SUM                  | 65             | 113              | 270            |                     |                        |
Gain Ratio = gain score

Post test maxm - pretest maxm score for a student.

Average time = \[
\frac{\text{Total Time}}{\text{No. of Students}}
\]

When the average gain is less than 60% the programme will be revised. If it is more than 60% the programme need not be revised.

**Objective Based Teaching :-**

Bloom and Krathowal analysed human behaviour and classified into domains abilities. According to Bloom in the cognitive domain four objectives, knowledge, application and skill are considered in school education, these four objectives are considered as instructional objectives. The objective based teaching approach is based on these instructional objectives. The lesson plan of the scheduled topics for the experiment were prepared by the research scholar. The reliability and the validity of lesson plans were tested to small group of the sample.

4.4. Validation of Programmes frames :-

The programmes of two topics (1) Simple equation and the other (2) Quadratic equation were prepared after doing developmental testing and were put to the field test. The object of field test is to find out whether the programme satisfactory achieved the stated objectives, when used with the target population. This is the validation of test generally done.

For validation, first the pre-test would be given to a group of students selected for this purpose. To that group of students the pre-test was given. Their responses were analysed. It was found that the correct responses were low. The programme was then administered the group. They were asked to write down their responses.
Calculation

Total items = 30
Total items = 30 minutes
Total No. of pupils = 30
Total No. of errors = 65
error rate = $\frac{65}{300} = 0.216$

$\frac{300}{30} = 21.6\%$

Average gain score = \[ \frac{\text{Total gain score}}{\text{No. of pupils}} \]

$\frac{6.5}{70 \times (23-15)}$

$= \frac{65}{80} = 0.802$

$= 80.2\%$

Average time = \[ \frac{270}{10} = 27 \text{ minutes.} \]

<table>
<thead>
<tr>
<th>Serial No. of pupils</th>
<th>Pretest scores</th>
<th>Post test scores</th>
<th>Gain in scores</th>
<th>Error in post test</th>
<th>Total time in post test</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>24</td>
<td>14</td>
<td>6</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
<td>23</td>
<td>07</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>24</td>
<td>8</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>25</td>
<td>9</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>25</td>
<td>13</td>
<td>5</td>
<td>22</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>26</td>
<td>10</td>
<td>4</td>
<td>24</td>
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<tr>
<td>7</td>
<td>16</td>
<td>20</td>
<td>4</td>
<td>10</td>
<td>25</td>
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<tr>
<td>8</td>
<td>10</td>
<td>25</td>
<td>15</td>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>9</td>
<td>11</td>
<td>23</td>
<td>12</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>24</td>
<td>14</td>
<td>6</td>
<td>26</td>
</tr>
</tbody>
</table>

96 61 257
Calculation

Total items = 30
Total time = 30 minutes
Total No. of pupils = 10
Total No. of errors = 61
Error rate = \( \frac{61}{300} = \frac{203}{3} = 203\% \)

Average gain score = \( \frac{\text{Total gain scores}}{\text{No. of pupils (Maxm post test - maxm pretest)}} \)

\[ = \frac{90}{10 \times (26-16)} = \frac{90}{100} = \frac{90}{100} = 90\%

Average time = 257 = 25.7 minutes

4.5. Testing Strategy:

(1) Reasoning and the mathematical ability test was developed by the investigator (appendices J, L, M).

(2) One pretest and two post tests were developed by the research scholar for the non-availability of standard test on the corresponding topics. It was developed in the form of standard test. The reliability and validity as well as item analysis of those tests were also carried out. (detail in appendix G)

4.6. Standardisation of Tests:

The standardisation of teacher's made 'pretest' and 'post test' were done by administering those tests in two selected groups of pupils, one from urban and the other from rural and the tests were conducted in a proper manner. The answer - scripts were
scor ed and the scores so obtained were statistically computed. The reliability and the validity of the tests along with items analysis were done.

4.7 RELIABILITY TESTS:

For the non availability of standard tests to measure the achievement of pupils in specific area/topic, the investigator had developed three tests, one pretest and two post tests.

(a) Reliability of tests -

For reliability, the tests were administered to the selected group of pupils under appropriate circumstances. The reliability of a test is expressed in terms of correlation coefficient called Reliability coefficient. There were various methods for estimating reliability coefficients. Among those, the investigator preferred the method of Rational Equivalence, this method was free from objections raised against other methods. This method stressed the interconnection of the items of the test and the correlation of the items of the test as a whole. There were four forms of the formula of the above method for determining the test reliability out of which the one given below was considered here. The formula is:

\[ r_w = \frac{n\sigma^2 - M(m-M)}{\sigma^2 \times (n-1)} \]

in which

- \( r_w \) = reliability coefficient of the test
- \( n \) = number of items in the test
- \( \sigma^2 \) = standard deviation of the test scores
- \( M \) = The mean of the test scores.
The assumption to be made in the above formula is that almost all test items have the same difficulty value (items analysis shown in appendix). The above formula provides a fairly good index of the test reliability even when equal items difficulty is not satisfied.

4.8 Validity of test:

The validity of a test depends upon the fidelity with which it measures what it purports to measure. Validity is a relative term. A test is valid for a particular purpose or in a particular situation. It is not generally valid. Four types of validity have been identified and are commonly used in Educational and psychological measurements. There are content validity, Predictive validity, concurrent validity and construct validity. These types are applicable to all types of evaluation tools. So test makers who have no real evidence about the validity of their test emphasise the reliability of the test but Validity is always the first requirement to be sought in a test and reliability is a valuable auxiliary.

The validity of a test here is to measure its content validity for which objective type tests, one pretest, and two post tests. The Validity and reliability of these tests were worked out to measure the test efficiency. Items analysis had been carried out to test the adequacy of those tests. What are its purposes, is depended upon the care with which the items of the test have been chosen. So item analysis of the teacher made test mentioned above had been carried out (detailed work shown in appendix).
In order to know the previous knowledge of the pupils selected for the experiment, the pretests for class IX and class-X were administered. The tests were objective type multiple choice. It contained 35 items carefully chosen after consulting some standard reasoning arithmetic ability tests.

The reliability and validity of the above test scores so obtained were calculated as follows:

For the reliability coefficient, $r_{u}$ is given by

$$r_{u} = \frac{n\bar{t}^{2} - M(n-M)}{6^{2}t (n-1)}$$

and the validity of the test score $= \sqrt{r_{u}} = r_{100}$

= Index of Validity.

Calculation.

(a) Pretest for class IX,

$$n = 32 \text{ mean } = M = 13.1875$$
$$\text{s.D. } = 6t = 4.3429$$

reliability coeff = $r_{u} = .6067$

and validity

$= \sqrt{r_{u}} = .7789$

(b) Pretest for class X.

$$n = 25, M = \text{mean } = 15.1236$$
$$\text{s.D. } = 6t = 3.8741$$

reliability coeff = $r_{u} = .6269$

and validity

$= \sqrt{r_{u}} = .7918$

(c) Post test for class IX,

$$n = 33 \text{ mean } = M = 16.44$$
$$\text{s.D. } = 6t = 4.3325$$

reliability coefficient = $r_{u} = .57801$

and validity

$= \sqrt{r_{u}} = .7602$
(d) Post test for class X.

\[ n = 25, \text{ Mean } M = 14.28 \]
\[ \text{S.D.} = 6t = 5.3328 \]

reliability coefficient \( = r_y = 0.8173 \)
and validity \( = r_y = 0.9041 \)

Summary of results at a glance

<table>
<thead>
<tr>
<th>Test</th>
<th>No. of test items</th>
<th>Mean Score</th>
<th>S.D.</th>
<th>Reliability Coefficient ( r_y )</th>
<th>Index of Validity ( \frac{r_y}{\sqrt{N}} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest for Class-IX</td>
<td>32</td>
<td>13.1875</td>
<td>4.3429</td>
<td>0.6067</td>
<td>0.7789</td>
</tr>
<tr>
<td>Pretest for Class-X</td>
<td>25</td>
<td>15.1236</td>
<td>3.8741</td>
<td>0.6269</td>
<td>0.7918</td>
</tr>
<tr>
<td>Post Test for Class IX</td>
<td>33</td>
<td>16.44</td>
<td>4.3325</td>
<td>0.57801</td>
<td>0.7602</td>
</tr>
<tr>
<td>Post Test for class X</td>
<td>25</td>
<td>14.28</td>
<td>5.3328</td>
<td>0.8173</td>
<td>0.9041</td>
</tr>
</tbody>
</table>

4. Items Analysis:

The items analysis for each of the above four tests was also carried out using normal procedure of the analysis. The difficulty level \( (DL) \) and the discrimination power \( (DP) \) of each item had been calculated using the following formula:

For item difficulties, value (in percent)

\[ D_{L} = \frac{R \times 100}{N} \]

\( R \) = No. of correct answer of each item
\( N \) = total number of items.
For items discriminating power (D)

\[
D_p = \frac{U - L}{N/2}
\]

in which

\[U = \% \text{ correct } 27\% \text{ top scores}\]
\[L = \% \text{ correct } 27\% \text{ bottom scores}\]
\[N = \text{Total no of pupils}\]

From the result of the items analysis, items which were found to be discorded and useless, those items were eliminated from the test items and after screening all the defective items the test items for the actual test had finalised. (Details of items analysis shown in appendix D, E, H) thus the pretest and post test question paper had been standardised and the scoring keys of the respective test had also been prepared. Each test was of 30 minutes duration and was of 25 to 30 selected items. The necessary instruction to pupils to answer the test items had also been incorporated in each question paper.

The investigator, before starting actual teaching of the topics for the experiment, intended to measure the general mathematical ability of the selected groups (Experimental and control) of each school chosen for the purpose of study. For this purpose, he administered, the reasoning and Arithmetical ability test also. After this test, in order to test the previous knowledge of pupils for teaching of new topics one. Pretest - one for: class-IX and for class- X groups (control and experimental) were administered in a congenial atmosphere. Each test was of 30 minutes duration having objective type questions. The answer scripts were scored and the data were preserved for analysis.
The marks of the annual examination of these selected groups of pupils had been collected from the respective schools. Immediately after the pretest as per time table (Table 4,2). The research scholar started teaching the experimental groups using new teaching methods and the control group was taught by an expert mathematics teacher using traditional method. After the teaching of the topics was over, the post tests had been administered to both the groups. The answer scripts had been scored and the data were preserved for statistical analysis.

The teaching was continued in the same procedure in the selected schools as per time table. To complete the whole scheme of teaching almost four months required because of climatic condition, seasonal variation, vacation of schools and other stipulated holidays. The photographs of activities of teaching were also shown here (Plate Nos. 4,2,3.)

4.0 Data Collection

(1) Annual Examination marks obtained by the selected pupils of the experimental and control groups were collected from the respective school. In case of the pupils of class X, marks obtained in the half yearly examination was taken into consideration. Marks were collected separately in case of urban and rural schools.

(2) The pretest - scores of the pupils of experimental and control groups in classwise and areawise were recorded separately.

(3) The post test scores obtained by pupils of experimental and control groups were collected classwise, areawise (urban and rural) and method of teaching wise. Altogether there were 16 sets of marks to be recorded.
Treatment of data

1. To find out the mean (M), standard deviation (S.D.) variance, coefficient of correlation between pretest scores and post test scores of selected groups of pupils.

2. To calculate the significant difference of means by using 't'-test

3. To find out, M, SD, variance coefficient of correlation and t' value between scores of pretest and that of the post test of the experimental group using (i) Programme Instruction method
   (ii) Integrated Programme Instruction.
   (iii) Objective based Instruction.

Separately in class wise and in area wise- So there were 12 sets of marks.

4. To compare the performance of pupils of control with the experimental group with different methodologies used and the comparison was made class wise and area wise. Here also sets of marks to be treated.

5. The comparison among new instructional methods class wise and area wise 24 sets of marks to be treated.

6. Analysis of covariance of three new methods to be calculated in class and area wise.


Plan of testing Experimental group area wise and class wise:

Class IX: Experimental group

   Urban
   P.I. methods (before and after teaching)
   I.P.I. methods (before and after teaching)
   O.B.T. methods (before and after teaching)
The test scores were analysed in the next chapter using the plan procedure stated above.

4.12 MODE OF CALCULATION

All the statistical computations in the present study were carried out at the computer centre of the Assam Engineering College, Guwahati. In (Appendix - I)