DESIGN
AND
PROCEDURE
CHAPTER III

DESIGN AND PROCEDURE

3.0.0 INTRODUCTION

It is said that fate of any activity and its outcome depends essentially upon its design. Design provides a picture of what and how to do the work before starting it. In any research project, design provides the investigator a blueprint of research, dictates the boundaries of project, and helps in controlling the experimental, extraneous and error variances of the problem under investigation. Fred N. Kerlinger (1974) described, "Research design as the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and control variance".

The present investigation purports to measure the effect of four classroom presentation modes on the achievement of secondary students in science. The present chapter deals with the plans including the details of methodology for the present study in the form of its overall design, variables, selection of sample, tools used, procedure for data collection and statistical techniques used.

3.1.0 DESIGN

In the present venture, effect of four presentation modes viz. (i) demonstration mode (DM), (ii) video instructions mode (VM), (iii) video instructions followed by
teacher's discussion mode (VDM) and (iv) students' learning through self-experimentation under the guidance of teacher mode (SLM) was studied on the achievement of secondary students in science. To achieve the objectives Pre-test Post-test group design was employed. The design envisaged four groups of students of tenth class of four different secondary schools. Each group consisted of forty students taken from a school for teaching science through a particular presentation mode. The schools were selected from urban area and with same curriculum and administrative pattern. The students were administered Group Intelligence test and Socio-Economic Status scale. Pre-achievement of these students i.e. their scores in ninth class was noted from school records. The scores of intelligence test, socio-economic status scale and pre-achievement in science were the control variables. The study was completed in three stages. First at the Pre-test stage an achievement test developed by the investigator himself, was administered to all the four different groups and the scores obtained were recorded. At the second stage of experimental treatment, each group was taught through a particular presentation mode. One group was taught through demonstration mode, second group was dealt with video instructions mode, third group was put to the video instructions followed by teacher's discussion mode and the fourth group of students
<table>
<thead>
<tr>
<th>S1</th>
<th>Measurement of</th>
<th>S2</th>
<th>Measurement of</th>
<th>S3</th>
<th>Measurement of</th>
<th>S4</th>
<th>Measurement of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(a) Intelligence</td>
<td></td>
<td>(a) Intelligence</td>
<td></td>
<td>(a) Intelligence</td>
<td></td>
<td>(a) Intelligence</td>
</tr>
<tr>
<td></td>
<td>(b) Socio-economic status</td>
<td></td>
<td>(b) Socio-economic status</td>
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<td>(b) Socio-economic status</td>
<td></td>
<td>(b) Socio-economic status</td>
</tr>
<tr>
<td></td>
<td>(c) Pre-achievement in science</td>
<td></td>
<td>(c) Pre-achievement in science</td>
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<td>(c) Pre-achievement in science</td>
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<td>(c) Pre-achievement in science</td>
</tr>
<tr>
<td></td>
<td>(d) Administration of achievement test</td>
<td></td>
<td>(d) Administration of achievement test</td>
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<td>(d) Administration of achievement test</td>
<td></td>
<td>(d) Administration of achievement test</td>
</tr>
<tr>
<td></td>
<td>Experimental treatment stage (Demonstration mode)</td>
<td></td>
<td>Experimental treatment stage (Video instructions mode)</td>
<td></td>
<td>Experimental treatment stage (Video instructions followed by teacher's discussion mode)</td>
<td></td>
<td>Experimental treatment stage (Students' learning through self-experimentation under the guidance of teacher mode)</td>
</tr>
<tr>
<td></td>
<td>Post-test stage (Administration of achievement test)</td>
<td></td>
<td>Post-test stage (Administration of achievement test)</td>
<td></td>
<td>Post-test stage (Administration of achievement test)</td>
<td></td>
<td>Post-test stage (Administration of achievement test)</td>
</tr>
</tbody>
</table>

**FIGURE 3.1 SCHEMATIC PRESENTATION OF DESIGN**
had to carry on through students' learning through self-experimentation under the guidance of teacher mode. The experiment was conducted for about three months. After the experimental treatment, achievement of all students was again noted with the help of same achievement test. This stage was called as Post-test stage.

3.2.0 IDENTIFICATION OF VARIABLES

In experimental researches the relationship between two types of variables is studied - independent and dependent variables. Independent variables are the causes and dependent variables are the effects. Another category of variables, which is also equally important, is intervening variables. All these three kinds of variables which were identified for the study are discussed as here under :-

3.2.1 Independent Variables

Experimental treatment (presentation modes) was the independent variable which was taken into consideration in order to see its effect on the achievement of students. There were four presentation modes which constituted the experimental treatment. These four presentation modes were demonstration mode, video instructions mode, video instructions followed by teacher's discussion mode and students' learning through self-experimentation under the guidance of teacher mode. All the four groups of the sample
were treated with these presentation modes separately i.e. one group was taught with one presentation mode only. The treatment was provided for the science subjects only i.e. Physics, Chemistry and Biology for a period of three months.

3.2.2 Dependent Variables

Achievement was the main dependent variable. Achievement of the students was measured twice, first at the pre-test stage and secondly at the post-test stage with the help of an achievement test prepared by the investigator.

3.2.3 Intervening Variables

There were certain variables which also have their effect on the outcome of learning. Both the independent and dependent variables can be influenced by such variables known as intervening variables e.g. nature of school, intelligence of students, socio-economic status of students, grade level, study habits and prior knowledge of the topics etc. Such intervening variables were controlled either experimentally or statistically.

3.3.0 Controls Employed

It is necessary to control all those variables that may affect the dependent variable. Hence suitable controls were employed for each particular variable.
<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
<th>Intervening Variables</th>
<th>Control Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Four Presentation Modes</td>
<td>1. Achievement in science</td>
<td>1. Nature of school</td>
<td>1. Administrative (Govt. School - same administrative and educational practices)</td>
</tr>
<tr>
<td>(a) Demonstration mode (DM)</td>
<td></td>
<td></td>
<td>2. Statistical (ANCOVA)</td>
</tr>
<tr>
<td>(b) Video instructions mode (VM)</td>
<td></td>
<td></td>
<td>3. Administrative (10th class)</td>
</tr>
<tr>
<td>(c) Video instructions followed by teacher's discussion mode (VDM)</td>
<td></td>
<td></td>
<td>4. Statistical (ANCOVA)</td>
</tr>
<tr>
<td>(d) Students' learning through self-experimentation under the guidance of teacher mode (SLM)</td>
<td></td>
<td></td>
<td>5. Statistical (ANCOVA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6. Administrative (different presentation modes in different schools)</td>
</tr>
</tbody>
</table>

**TABLE 3.1 VARIABLES**
3.3.1 Nature of the school

The four different schools selected for the study were government-run-schools having same structure of administration, philosophy of education and other educational practices. All the four schools were situated in urban area.

3.3.2 Socio-Economic Status

This variable was controlled statistically by employing ANCOVA for the scores obtained by administering Socio-Economic Status Scale (by Kuppuswamy).

3.3.3 Grade level

Tenth class was selected for the study and grade level thus kept constant during the study.

3.3.4 Intelligence of students

This variable has also its effect on the achievement. Intelligence test scores were obtained by employing Prayag Mehta's Group Intelligence Test. This variable was controlled statistically by employing ANCOVA.

3.3.5 Previous knowledge of the topics

Previous knowledge of the students can affect the achievement. The scores obtained by each student of the sample in ninth class in science subject were noted from school records and control was employed through ANCOVA.
3.3.6 Contamination effect

The contamination variable could affect the study in two ways. First the mixing of students could result in exchange of ideas regarding the experiment being done in their class. This variable was controlled by having different presentation modes in the form of experimental treatment in different schools i.e. one and only one presentation mode was presented in one school. Another way of contamination could be due to the extra knowledge acquired by the pupils after school hours, like in the form of coaching. To control this, the school staff and parents/guardians were requested along with the students, not to have any such extra-study or coaching. The school staff, parents/guardians and students all cooperated. Like this the contamination effects were minimised.

3.4.0 Sample

The sample for the present study was taken out from the four different secondary schools of Rohtak. The schools selected had the same curriculum and same administrative pattern for the tenth class. There were many students in the tenth class. Out of these, forty students were selected at random for one group. Thus four groups of forty students each from four different secondary schools constituted the sample for the present investigation.
3.5.0 TOOLS USED

Two types of tools were used in the present investigation namely-instructional tools and measuring tools. The instructional tools in the form of lesson plans, video lessons and text books were used to impart education to the students in physics, chemistry and biology. With the help of these instructional tools students were taught through four different presentation modes. The measuring tools employed were- an achievement test, intelligence test and a socio-economic status scale. The achievement test was developed by the investigator himself whereas intelligence test by Prayag Mehta and socio-economic status scale by B. Kuppuswamy were used. Both types of tools are described as here under :-

3.5.1 INSTRUCTIONAL TOOLS

Instructional material was developed in the form of lesson plans and video instructions lessons to teach the students. The students were taught physics, chemistry and biology based on these lesson plans and video lessons. Video instructions lessons were used for teaching science through video modes. The text books of science subjects for the tenth class were used for teaching through SLM.
(a) VIDEO INSTRUCTIONS LESSONS

For teaching-learning process or for any other type of communication of instructions, video medium is proving to be the very powerful and versatile of all audio-visuals. Video medium of providing instructions has greater potential of creating special effects like controlling time and space, to create illusion for a desired visual impact, showing any action in fast motion, reverse motion or in slow motion. These properties have peculiar place or value in science subjects. Various topics need be shown in different dimensions of time and space. Sometimes the science topics and their demonstrations consists of a series of sequences like various chemical reactions, interactions of various elements, physical, chemical and biological properties of any system etc. These sequences incorporate live effect, animation and designed graphics related to that issue or topic. These video lessons or live audio-visuals are very helpful in clarifying closely related concepts. Human learning is also assisted by simulation, both in sciences and social sciences. The complicated systems, processes, dangerous experiments in chemistry, physics or biology or engineering can be effectively and easily explained to the students as simulation with the help of video mode of teaching. Hence keeping in view the possibilities to simulate the human interaction, for example, between
### TABLE 3.2

**LIST OF VIDEO LESSONS**

<table>
<thead>
<tr>
<th>PHYSICS</th>
<th>CHEMISTRY</th>
<th>BIOLOGY</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Reflection of light</td>
<td>5. Petroleum</td>
<td>5. Sex determination</td>
</tr>
<tr>
<td>10. Radioactivity</td>
<td>10. Radioactivity</td>
<td>10. Improvement of crops</td>
</tr>
</tbody>
</table>

The scripts of video lessons are given in Appendix-F.
teachers and students, the instructions given through such medium were named video mode. The video mode of teaching consisted of two types of material - hardware and software. The hardware included the electronic gadgets like television and video cassette recorder (VCR). The software consisted of video lessons which were recorded on the video cassettes.

Television and VCR were used as an electromechanical devices to teach the students. Ten lessons each from physics, chemistry and biology of tenth class were recorded on magnetic video cassette tape. The video lessons were developed at TV Centre, near Vigyan Bhawan, New Delhi because all the facilities for recording and editing were available there. The average duration of the video instructions lessons was 25-30 minutes. The salient features of the video instructions lessons were:

1. The graphics were generated letter by letter with a videotister and captions were shown wherever required.
2. All the spoken words/commentary were supplemented by visuals at appropriate place.
3. Excerpts from films were also taken as support medium.
4. Minor details of any figure or object were enlarged with the help of zoom lens.
5. Wherever possible, real objects like chemicals
compounds, places and plants etc were used or shown. In the case of non-availability of real material the topic was explained with the help of models.

(b) LESSON PLANS

Ten topics were selected from three science subjects - physics, chemistry and biology comprising thirty lessons in total. The topics of lesson plans were same as those of video lessons so as to avoid the intervening variable of content/topic. The objectives of the lesson plans were defined in behavioural terms. Entering behaviour of the students was also kept in mind while preparing lesson plans by framing specific questions. The subject matter was divided into three columns (a) content matter, (b) method and (c) blackboard summary. All the required essential aids were also prepared so as to explain the nature of topic. These aids were used by the teacher during teaching. In the last, recapitulative questions were prepared so as to revise the lesson.

The lesson plans are given in the Appendix -G.

3.5.2 MEASURING TOOLS

The measuring tools i.e. an achievement test in science prepared by the investigator himself, an intelligence test (by Prayag Mehta) and a socio-economic status scale (by Kuppuswamy) were employed to collect the requisite data.
(1) **ACHIEVEMENT TEST**

"The principal object of achievement test is to appraise the effects of a course of instruction or training" (Anastasi, 1961). Gronlund (1988) described an achievement test as a systematic procedure for measuring a representative sample of learning tasks. To realise the objectives of the study the investigator constructed an achievement test in science for measuring the achievement of secondary students. The steps followed for the construction of test are described as here under:

(a) **Planning the test**

The key to effective achievement testing is careful planning. Test planning involves determining the purpose of the test, identification and defining the intended learning outcomes, preparing the test specifications and construction of relevant test items (Gronlund, N.E., 1988). To construct the achievement test in science for the present study, the objectives were defined in behavioural terms. Since the concern here was with achievement testing, the researcher focused primarily on the cognitive domain. Taxonomy of educational objectives (Bloom and others, 1956) was useful guide for approaching this task. Intellectual outcomes in the cognitive domain were divided into two major classes (a) knowledge and (b) intellectual abilities and skills. After the determining of objectives the learning outcomes were
stated as terminal performance which is observable. Before the writing of any items, test specifications should be drawn up. According to Anastasi (1961), the test constructor who plunges directly into item writing is likely to produce a lopsided test. If any constructor does not have an advance plan, some areas may be overrepresented while some topics may be left. It can result into disproportion of items i.e. some topics will be having more coverage of items and some less.

For preparing the test specifications, the investigator studied two types of literature critically: (i) related with the test construction and (ii) syllabus and previous question papers in science of tenth class.

Several books on achievement test construction or on the use of test in education written or edited by Lindquist, Travers, Guilford and Lacey, Gronlund, Anastasi, Cronbach, Greene, Jordan, Ross and Stanley, Wood and Freeman etc. were very helpful. Most of these publications include discussions of how to write and edit items and the procedures of standardising the items.

Examining the course content can be called as curriculum analysis. A comprehensive study of curriculum and text books related to physics, chemistry and biology of tenth class was made. Various question papers, question bank series
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Subject</th>
<th>Content</th>
<th>Weightage in percentage</th>
<th>No. of items proposed for the final test draft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physics</td>
<td>Solar system</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Physics</td>
<td>Mechanics</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Physics</td>
<td>Sound</td>
<td>30 %</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Physics</td>
<td>Optics</td>
<td>43 %</td>
<td>14</td>
</tr>
<tr>
<td>5</td>
<td>Physics</td>
<td>Radio activity</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Chemistry</td>
<td>Metals</td>
<td>30 %</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>Chemistry</td>
<td>Industrial preparations</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>Chemistry</td>
<td>Carbon compounds</td>
<td>43 %</td>
<td>14</td>
</tr>
<tr>
<td>9</td>
<td>Chemistry</td>
<td>Radio activity</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>10</td>
<td>Chemistry</td>
<td>Minerals</td>
<td>9 %</td>
<td>3</td>
</tr>
<tr>
<td>11</td>
<td>Biology</td>
<td>Heredity</td>
<td>47 %</td>
<td>16</td>
</tr>
<tr>
<td>12</td>
<td>Biology</td>
<td>Diseases</td>
<td>20 %</td>
<td>7</td>
</tr>
<tr>
<td>13</td>
<td>Biology</td>
<td>Theories of evolution</td>
<td>12 %</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>Biology</td>
<td>Flow of energy</td>
<td>12 %</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>Biology</td>
<td>Crops</td>
<td>9 %</td>
<td>3</td>
</tr>
</tbody>
</table>
published by Association of Indian Universities, model question papers set by School Board helped the researcher to decide the weightage to be given to each independent topic of each subject.

(b) Administration of the test for Pre-Try-Out

Keeping in view the objectives, expected outcomes in behaviour and course content, objective items were framed. A large number of items for the purpose of the study were prepared by the investigator from physics, chemistry and biology. Text books and model question papers of tenth class supplied by the School Board were very helpful for this. The items with wide range of difficulty were constructed. The typed drafts were submitted to various teachers teaching the particular subject and experts with long teaching experience. The experts having experience of test construction were also consulted for frank opinion and criticism. Many false assumptions, slips and oversights were corrected and improved in this process. Some items which were irrelevant, inappropriate and ambiguous, were sorted out. The number of try-out items was considerably larger than the number needed for the final test draft (Lindquist, 1955). Thus in the last, 185 items were selected for the preliminary draft of the achievement test. The instructions to be given to the testees were framed. Then seventy
cyclostyled copies of the preliminary draft were administered to seventy students of tenth class of Govt. Boys Senior Secondary School, Rohtak during December 1988 and the answers were checked. A few further modifications came to light during this process, called the pre-try-out. Then the test was got cyclostyled and administered to the sample selected for try-out testing.

(c) **Try-Out for Item Analysis**

The try-out testing was done during February 1989.

(d) **Sample for Try-Out Testing**

The population for the try-out testing consisted of the students of Xth class of various high and higher secondary schools of Rohtak. Out of the many schools, five schools were selected at random. As there were many students in these schools, 400 students were selected in clusters of class sections at random from these schools.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Name of school</th>
<th>Total strength</th>
<th>Sample taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jat H M A S High School, Rohtak</td>
<td>235</td>
<td>180</td>
</tr>
<tr>
<td>2</td>
<td>Govt. Girls High School, Model Town, Rohtak</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>Govt. Boys High School, Gandhi Nagar, Rohtak</td>
<td>45</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>Govt. Boys Senior Secondary School, Rohtak</td>
<td>50</td>
<td>50</td>
</tr>
</tbody>
</table>
As the researcher needed 372 scripts for item analysis, he took 400 scripts to keep enough margin for discarding the spoilt ones.

(e) **Instructions to the testees**

The written instructions were as shown on the title of try-out test. Alongwith written instructions, some oral instructions were also given to the students at the time of conducting the try-out test. Though the written instructions were very clear, comprehensive and self-explanatory about how to answer a multiple choice item, these were also explained verbally and on the blackboard. The oral instructions were as here under:

(i) Do not discuss anything with your neighbours.

(ii) Do not make unnecessary haste to finish the test.

(iii) Please see that no item is left unanswered. You have to answer all the items. At the end, we shall check whether you have answered all the items.

(iv) Your sincere and honest effort will help me a lot in my endeavour.

(v) Please write your name, roll number, name of
(vi) Please go through the written instructions carefully before you start answering the items.

(f) **Time Limit**

There was no time limit for taking the try-out test. All the copies were collected when the testees had answered the try-out test.

(g) **Scoring**

The scoring was done with the help of scoring key already prepared by the investigator. There was one mark for a correct answer and an outright zero for an incorrect answer.

The try-out test and scoring key are given in Appendix - A.

(h) **Item Analysis**

After scoring the try-out test, the investigator took 372 answer sheets by deleting the rest at random. The following steps were followed for item analysis:

(i) Firstly, all the 372 answer sheets (scripts) were arranged in the descending order from highest score scripts at the top to the lowest score ones at the bottom.

(ii) Then secondly, selected the upper 100 scripts with the highest scores, called as "upper group" and selected the same number of scripts with the lowest scores and called
this "lower group". The middle group of scripts were set aside. Thus 27 percent of 372 students, 100 answers sheets constituting upper group and 100 answers sheets making lower group were taken into consideration for computing internal consistency discrimination index and the difficulty value.

(iii) Thirdly, after the formation of two groups, the number of correct responses to an item in each group was found out and tabulated. The difficulty of an item is indicated by the total number of students who answered it correctly, the larger this number the easier the item. Item difficulty was estimated by determining the percentage of students who answered the item correctly. Here these numbers, naturally, showed the percentage of correct responses for each item for both groups, as each group comprised of 100 testees. The percentages were converted into proportions. The average of the proportion of correct responses on each item in the two end groups was taken to be an estimate of the difficulty value of that particular item.

The formula for computing difficulty value \( dv \) of each item was:

\[
dv = \frac{Pu + Pl}{2}
\]

where \( dv \) = difficulty value of the items

\( Pu \) = proportions of correct responses to the items from the upper group
When this formula is applied, the middle 46 percent cases are discarded. Regarding reliability of the dv of the items calculated by this method, Davis (1951) compared the reliability coefficient of a group of typical item difficulty indices estimated in this same way and has found it to be 0.98 when the sample included 100 examinees in the highest 27 percent group and 100 examinees in the lowest 27 percent group.

(i) **Internal Consistency Discrimination Index (rb)**

The relationship between the total scores derived from a test and item scores are referred to as internal consistency discrimination index of an item. This was found by reading the biserial coefficient of correlation between item and total score from the J.C.Flanagan's abac. Flanagan's abac was designed for use when the sample has been restricted to the highest and lowest 27 percent of the total score distribution and middle 46 percent of the examinees of the total score have been eliminated. The proportion of examinees passing the item in the upper criterion group was read on the ordinate and the corresponding proportion from the lower criterion group was read on the abscissa. The value of the coefficient rb was read at the intersection of perpendiculars at these values.
When the difficulty values and the internal consistency discrimination indices of each item had been determined, as stated above, items for final draft were selected.

The list of the items showing 'dv' and 'rb' are given in Appendix - B.

(j) Final selection of the items

Final selection of the items was made on the basis of difficulty value and discrimination index of each item.

(i) Difficulty value

Most of the items selected were having medium difficulty value and few items with high and low difficulty values were also taken. Lindeman (1971) emphasised that easy items should be included in a test in order to encourage the students of low ability. Some difficult items should be included to challenge the abler students. However, in the interest of constructing a measuring instrument of maximum quality and utility, most items included should be in the middle range of difficulty.

(ii) Internal Consistency Discrimination Index

According to Garrett (1967) items with validity indices of 0.20 or more are regarded as satisfactory. Thorndike (1955) considered an item with a validity coefficient as high as 0.25 as an outstanding 'valid' item. Hence the researcher retained those items for the final
draft which were having internal consistency of 0.25 and higher. The items with zero discriminating power and negative discriminating power were discarded while selecting items for final draft.

Gronlund (1988) states, "Zero discrimination power (0.00) is obtained when an equal number of students in each group answers correctly. Negative discriminative power is obtained when more students in lower group answer correctly than students in the upper group. Both types of items should be removed from norm-referenced tests and then discarded or improved."

A bivariate scatter diagram was prepared for the items of the achievement test, placing each item in the appropriate column and row according to its difficulty value and discrimination index respectively. Thus 100 items were selected keeping in view the above criteria for final test.

The bivariate scatter diagram is given in Appendix - B.

**TABLE 3.4**
The distribution of difficulty value (dv) and the internal consistency discrimination index (rb) of items finally selected:

<table>
<thead>
<tr>
<th>Difficulty value (dv)</th>
<th>f</th>
<th>Discrimination indices (rb)</th>
<th>f</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.70------0.70</td>
<td>5</td>
<td>0.70------0.79</td>
<td>0</td>
</tr>
<tr>
<td>0.60------0.69</td>
<td>29</td>
<td>0.60------0.69</td>
<td>0</td>
</tr>
<tr>
<td>0.50------0.59</td>
<td>26</td>
<td>0.50------0.59</td>
<td>13</td>
</tr>
</tbody>
</table>
Standardisation of achievement test

100 items were selected for the final form of the achievement test. This selection sets the stage for the standardisation or experimental validation of the test which includes establishing reliability and validity.

(i) Reliability

Reliability refers to the consistency of test scores. The reliability was found by the split half method (odd-even method) and the coefficient of reliability came to 0.86.

(ii) Validity

Validity is the extent to which a test measures what it purports to measure (Cronbach, 1970). The validity of this achievement test was taken for granted because this achievement test was constructed after preparing the blue print and ascertaining the weightage of different topics and items. This is in concordance with Guilford (1971) who says, "There are some measures whose validity is taken for granted, for example, achievement test scores."

Content related evidence of validity is especially important in achievement testing. Gronlund (1988) emphasises that we can build a test that has high validity by (i)
identifying the learning outcomes to be measured, (ii) preparing a test plan that specifies the sample of the items to be used, and (iii) constructing a test that closely fits the set of test specifications. Anastasi (1961) had the opinion that content validity when applied to educational achievement test, is often called curricular validity. The preparation of test items is preceded by a thorough and systematic examination of relevant course syllabi and text books as well as by consultation with subject experts and test construction experts. Lindquist (1951) also says, "....the content of an achievement test is often formulated by analysis of curriculum and text books and by the pooled judgement of recognised authorities in the field. Under these circumstances, a well constructed test may constitute the best available measure of criterion, in a sense the test itself defines the function it is to measure. Such tests may be described as self-defining".

1) Final form of the test

The final form of the achievement test contained 100 items. On the cover of the test, instructions for the examinees were printed as were printed on the cover of try-out test. The directions how to answer the questions were also same as in try-out test. The key was prepared for the final test.

The final test alongwith the key is given in Appendix - C.
(m) **Time limit**

The time limit was fixed after conducting the test on a sample of 50 students of Xth class of Govt. Girls High School, Model Town, Rohtak. The time taken by 90 percent of these students was fixed as the time limit. 120 minutes were fixed as the time limit for the final test.

(2) **GROUP INTELLIGENCE TEST**

To determine the intelligence of students of the sample, Group Intelligence Test by Dr. Prayag Mehta was used. The test includes 60 items in total. Ten types of items i.e. based on logical selection, analogies, best answers, information, disarranged sentences, number series, classification, absurdities, inference and mathematical reasoning were included with 6 items each. The time limit for the intelligence was 18 minutes. The reliabilities of the test, at various age groups, range between 0.81 and 0.90. The test is also validated with internal validity and factorial validity.

For the administration of test, the test copies were distributed to the sample students and the instructions written on the test booklet were read aloud to the students. They were asked to complete the test in 18 minutes. After the time was over, test copies were collected and counted. The scoring was done with the help of scoring stencil. This stencil was adjusted on each page of the test so that the
three dots on the top right corner are visible through the holes on the top of the scoring stencil of that page. The correctly marked answers were clearly visible through the holes. The number was counted and entered in the box provided in the right margin of the test booklet. After scoring all pages, the entries were brought to the front page. All the scores were written in appropriate column to get the total score.

A copy of the test is given in Appendix - D.

(3) **SOCIO-ECONOMIC STATUS SCALE**

To determine the socio-economic status of students, the Urban form of the Socio-Economic Status Scale by B. Kuppuswamy was used, which is standardised primarily for use in socio-economic investigation in urban parts of India. The scale comprised of three important variables contributing to socio-economic status in urban areas. These are education, occupation and income. A seven point scale is used for each variable and an arbitrary weightage of 7 to 1 is given to each of the items of each of the three variables. The total score ranged from 3 to 21. The social classes are divided into five following groups:

I Upper
II Upper middle
III Lower mdddle
IV Upper lower
V Lower

Form - B called as Information Blank of the scale was used which is meant for the students to fill up the particulars regarding their parents or guardians. When the information in form-B is completed, this information was summarised in the Score Card. The weighted scores of all the three variables were added in order to get the final scores for socio-economic status. The classes were divided on the basis of total scores as

- 26-29 I
- 16-25 II
- 11-15 III
- 5-10 IV
- Below 4 V

It is assumed in the scale that the differences between categories is more significant than differences within each category. This scale assumes that in a modern society, there are three essential variables namely education, occupation and income which determine the socio-economic status. This scale has the merit of objectivity.

A copy of the scale is given in Appendix - E.

3.6.0 **PROCEDURE FOR DATA COLLECTION**

The study was completed in three stages. The method adopted for the conduct of each stage is as detailed here
3.6.1 Pre-Test Stage

Initially at the pre-test stage, pre-achievement of each student of the sample i.e. their scores in science subject of IXth class, was noted from the school records. The scores of intelligence test and socio-economic status scale were also collected by administering Prayag Mehta's Group Intelligence Test and Kuppuswamy's Socio-economic Status Scale. The scores of intelligence test, socio-economic status scale and pre-achievement in science were statistically adjusted by employing Analysis of Covariance. Then all the four groups were administered the achievement test prepared by the investigator himself. The scores thus obtained were recorded. This stage was called as Pre-Test stage.

3.6.2 Experimental Treatment Stage

Before the beginning of experimental treatment, all the four groups of students and teachers were made aware of the objectives and nature of the experiment to be conducted. This orientation helped the students to understand the instructions. The groups which were to receive instructions through video modes were explained the hardware and software in detail so as to overcome their curiosity and anxiety about the equipment in front of them.
After the administration of achievement test and taking the requisite data, experimental treatment was provided to all the four groups. Each group was taught through one presentation mode only. First group was taught through demonstration mode, second group through video instructions mode, third group was having video instructions followed by teacher's discussion mode and fourth group was assigned the task of learning through self-experimentation under the guidance of teacher mode. The lesson plans were prepared by the class teacher who taught through DM. All the necessary aids including charts, models, maps and graphs etc. were also prepared and demonstrations regarding various topics were given to the students. The students of second group were taught through VM where they observed video lessons. These video lessons contained all the necessary information related to the topic, supported by the visual photographs. There was no discussion during the lesson or at the end of lesson in VM. The third group was taught through VDM. In this mode the class teacher provided necessary information in the form of discussion at the end of each video lesson. Students of the fourth group were asked to learn through self-experimentation under the guidance of teacher. The students were provided requisite text books and guidelines about the unit. What was expected of them was also made clear. Thus four presentation modes were employed differently with the four groups. The duration of the
experiment was about three months. Thirty lessons were selected for the experiment i.e. ten lessons each from Physics, Chemistry and Biology. Each group was taught through one mode only and whenever needed the lesson was repeated so as to make the concept or point clear to the students.

3.6.3 Post-Test Stage

After the experimental stage was over, the same achievement test was administered again to all the four groups. The scores obtained at this post-test stage were recorded.

3.7.0 STATISTICAL TECHNIQUES USED

Statistics has become an indispensable tool for research. It is fundamental to the proper analysis of data. In order to fulfil the objectives of the present study, analysis of co-variance (ANCOVA) was employed as statistical technique. The intelligence test scores, socio-economic status scores and pre-achievement in science scores were adjusted as controls. In many experimental situations, sometimes a need arises to compare the groups which are at the start unlike in the variable under investigation or in related variable. A control of the intervening variables is required at the experimental stage so that the results obtained can be attributed to the treatment variable and to
no other causal factor. ANCOVA provides a method of statistical control of the differential in the criterion scores attributable to the covariate, where experimental control of a covarying variable or covariate has not been done (Aggarwal, 1988).

The other basic statistical measures used were Mean, Standard Deviation and 't' test. The 't' test was applied to test the significance of difference between the means of gain achievement scores of pupils in science taking two treatments together at a time. 't' test represents the ratio of the differences between the means to the standard error of the differences between the means.

\[
t = \frac{M_1 - M_2}{\sqrt{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}}
\]

where

- \(M_1\) = Mean of one group
- \(M_2\) = Mean of second group
- \(\sigma_1^2\) = Variance of first group
- \(\sigma_2^2\) = Variance of second group
- \(N_1\) = Number of cases in first group
- \(N_2\) = Number of cases in second group

Null hypotheses were framed for the present study. A null hypothesis states that there is no significant difference between the two parameters used. It concerns a
judgement as to whether apparent differences are true differences or they result from sampling error. Some level of confidence or significance has to be decided for the rejection or retention (acceptance) of a null hypothesis. This rejection or retention is seen at two levels 0.05 and 0.01 with the t-value of 1.96 and 2.58 respectively. If the t-value equals or exceeds 1.96 it can be concluded that the difference between the means is significant at 0.05 level. Thus we can reject the null hypothesis at 0.05 level of significance. The value of 't' was determined with the corresponding degrees of freedom entering in Table - D (Garrett, 1979).

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