CHAPTER IV

PLANNING OF THE EXPERIMENTAL DESIGN

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4.1 Introduction

Experimentation has gained ground as a scientific procedure of studying causal relationships between and among several variables. The procedure consists of a well formulated research problem, as reflected in the hypotheses, a well laid out details as to how treatments are to be assigned to the subjects as well method of data analysis. In brief, the term 'experimentation' carries with it the connotation of a detailed procedure which is systematic in nature and is applicable under controlled conditions. When educational research properly described as 'experimental' the investigator has to specify a finite set of testable hypotheses and has to establish a systematic programme of data gathering, under precisely defined conditions, in an effort to test those hypotheses.

Most of the basic experimental designs used in education and behavioural sciences have been adopted from the physical and biological sciences. An experiment is taken to mean a scientific investigation in which an investigator manipulates and controls one or more independent variables and observes the dependent variable
or, variables for variation concomitant to the manipulation of the independent variable. The typical experimental design in education involves hypotheses, assignment of treatments to experimental and control groups and finally the evaluation of the groups on the dependent variable.

4.2 Types of experimental designs

Historical research is concerned with "what was", descriptive research is with "what is", and correlational research with "what will be". Experimental research is concerned primarily with the attempt to explain "why and what really is". In other words, experimental research is concerned with ascertaining causal relationships under controlled conditions.

Recently, a vast number of research designs have been developed to meet the needs of investigators, depending on the area of the experimental work as well as the nature of the problem and purpose. A variety of experimental designs are available such as, One-group method, Matched group or Parallel group method, Rotation group method, Randomized group design, Randomized block design, Factorial design, Latin square design, for psychological research. Experimental designs in education are divided by Lehmann and Mehrens (1979)
(2) **The one-group pre test post-test design.**

This is an extension of the one-shot case study. A pre test is given, a treatment administered and then a post-test is given. Next, the investigator looks at the average performance on the pre-test, the average performance on the post-test and makes the assumption that if there is any gain between the pre and post-test, the gain is attributed to the treatment. The major deficiency inherent in this design, is not that the extraneous variables such as, history of subjects, reactive measures, maturation or regression are operating. The problem is that one can not ascertain, whether they have influenced the outcome of the experiment or not.

4.2.2 **Good research design**

There are many good experimental designs available to the investigator. For example, investigator can choose (1) Post test only control group design, (2) Pre test post-test control group design, (3) The Solomon four - group design and (4) Factorial designs.

(1) **Post test only control group design**

In this design, both a control and experimental group or groups are used. The dependent variable is
By only pre testing one-half of the groups, the investigator can ascertain the influence of the pre test; investigator can determine the influence of the treatment when pre-test is given and when it is not administered, and can observe the interaction effects of pre test and treatment.

(4) Factorial designs

These are really a misnomer since they are not designs in the conventional sense, rather, they are methods of analyzing data. Whenever an investigator is interested in studying the effect of two or more variables simultaneously; he employs a factorial design. This type of design requires a minimum of two independent variables. If each independent variable has only two levels, then it is called $2 \times 2$ factorial design.

The investigator considered the following objectives and hypotheses while planning the experimental design for the present study.

4.3 Objectives and Hypotheses

Objectives

1. To investigate into the efficacy of the instructional media: I (visual projection) over the instructional
media: II (Activities and experiment) in terms of achievement.

2. To investigate into the efficacy of the instructional media: I (Visual projection) over the instructional media: III (Programmed learning material) in terms of achievement.

3. To investigate into the efficacy of the instructional media: II (Activities and experiment) over the instructional media: III (Programmed learning material) in terms of achievement.

4. To investigate into the efficacy of the instructional media: I (Visual projection) over the Traditional method of teaching in terms of achievement.

5. To investigate into the efficacy of the instructional media: II (Activities and experiment) over the Traditional method of teaching in terms of achievement.

6. To investigate into the efficacy of the instructional media: III (Programmed learning material) over the Traditional method of teaching in terms of achievement.

Besides these major objectives the following objectives were also laid down for the study.

1. To develop the programmed learning material for two units of Algebra for standard IX.
2. To find out the error-rate of both the constructed programmes.

3. To develop other two instructional media, viz.
   (i) material for visual projection and
   (ii) material for Activities and experiment.

Hypotheses

The following are the hypotheses of the study;

$H_{01}$: There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: I (Visual projection) and the instructional media: II (Activities and experiment).

$H_{02}$: There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: I (Visual projection) and the instructional media: III (Programmed learning material).

$H_{03}$: There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: II (Activities and experiment) and the instructional media: III (Programmed learning material).
Ho_4 : There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: I (Visual projection) and the Traditional method of teaching.

Ho_5 : There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: II (Activities and experiment) and the Traditional method of teaching.

Ho_6 : There will not be a significant difference between the mean scores for achievement of the pupils who studied through the instructional media: III (Programmed learning material) and the Traditional method of teaching.

To test these hypotheses it was necessary to control some extraneous variables affecting the dependent variable. The details about the variables are discussed in the pages to follow.

4.4 Classification of variables

The aim of the present study is to arrive at findings regarding efficacy of different instructional media in teaching mathematics to the pupils of standard IX.
Mathematics is an important school subject closely related with many other school subjects. Mathematics is a discipline where development of concept is an important task. Hence, mathematics is focused upon here. Secondary school level and particularly IX standard was considered appropriate for purpose because, it is a pre- S.S.C. class and diversification takes place at standard Xth.

The criteria for deciding the efficacy of different instructional media, the investigator wished to take into consideration, was potentiality of the instructional media in terms of achievement.

Dependent variable

The criterion or the variable that is being predicted or the variable that is affected or influenced by the treatments is called the dependent variable. In the present investigation achievement was the dependent variable.

A very important issue in experimentation on instruction emerges due to the assumption of normality of variables, especially, of pupils' achievement which is most often taken as the dependent variable. In some of the experimental studies on instruction which are more of the developmental type, i.e. which aim at developing some
instructional media and utilising the relevant instructional media developed by the researcher, attempt has been made to look into instruction without the normality assumption, though achievement and other outcome variables are the criteria for investigating the efficacy of developed instructional media. The present investigation is also experimental in nature where, investigator developed three instructional media to decide their efficacy. Achievement was the criteria to judge the efficacy of these instructional media. Though achievement of pupils was considered as a dependent variable the normality in achievement was not assumed but, the level of pupils' achievement was taken care by adopting a pre test-post test design and the technique of Analysis of covariance considering pre test as a covariate.

**Independent variables**

Independent variables are variables over which the investigator has direct control and which he himself manipulates or changes. In the present investigation three treatments were given to experimental groups. These treatments were given by three different instructional media as such, instructional media was considered as a free independent variable or an experimental variable.
Three treatments involved in the present investigation were, (i) treatment given by Visual project, (ii) treatment given by Activities and experiment; and (iii) treatment given by Programmed learning material.

**Extraneous variables**

Those variables not explicitly taken into account in the research design that impede attributing all differences in the dependent variable are referred to as extraneous variables. It further indicates either something in the subjects' environment or some characteristic or trait of the subject which is beyond the control of the investigator.

**4.5 Control of variables**

In any experiment the control of variables is an important condition. But, in real setting of class room this becomes a very difficult constraint to be met as there is a long list of variables affecting pupils achievement in the class room. Some of them can be controlled by way of selecting an appropriate design but many of them are extraneous and beyond the control. As such, most of the experiment on instructional process have been carried out in the actual class room settings. Such studies in
the real classroom setting without proper controls provide general information regarding the variable under study without confidence and have less generability.

Present investigator controlled two prominent variables, one is reasoning ability and second is motivation towards school by matching the groups over them. In the following lines investigator has discussed about these two variables.

The investigator controlled the motivation aspect as it is an important aspect in the process of instruction. Motivation is related to man’s inner impulses and is closely associated with one’s values. Motivation gives direction and intensity to man’s behaviour. Motivation to learn in school is that which gives direction and intensity to pupils’ behaviour in a school situation. Pupils who possess fairly a high level of motivation are found enthusiastic and have positive aspect of self concept and values which give direction to behaviour. The young pupils who are motivated to learn in school value the abstract, the esthetic and the general. The pupils who are less motivated to learn in school tend to value the concrete and the particular. The enthusiasts tend to have healthy or realistic perception of time whereas
unenthusiastics have unhealthy perception of time.

Jack Frymier (1970) has studied this phenomena and explained it fully. The pupils who hate school are likely to be obsessed with the present, and afraid of the future or preoccupied with the past. The pupils who do not hate school tend to be more tolerant of the behaviour of the teachers and classmates, more open to experiences and have more perceptual energy to assimilate the new and the unknown. The pupils who are less motivated towards school are very closed to varied experiences. Generally, they are unfriendly to their classmates and tries to repel the learning experiences presented by the teachers. They show less uniqueness in their perceptual field. The pupils who are more positively motivated towards school show tendency to suspend their judgement more readily, tendency to move towards unfamiliar and unclear and tries to shake of prejudices slowly. Using scores on Junior Index of Motivation (JIM scale) groups were matched. Thus, the variable of motivation was controlled.

Another such variable controlled was reasoning ability. The group test of reasoning ability constructed and standardized by Dr. C. C. Pathak has been used for measuring reasoning ability. It has been proved that
reasoning ability is the crowning achievement of intelligence; as such most of the tests for intelligence are based on reasoning. By administering this test and matching the groups on its scores, the present investigator was able to control this variable.

Over and above these, another two equally important independent variables were also controlled. They are, (i) subject matter content and (ii) the teacher. Investigator decided to select two units from the textbook of algebra for standard IX for all the three instructional media. That means the content was the same for all the treatments thereby it was controlled. Present investigator had decided to provide all the three treatments to different experimental groups himself. He had also decided to teach the control group with traditional method of teaching i.e. chalk and talk method. Thereby an attempt was made to control the teacher variable.

4.6 Specification of research design

A research design is a plan, structure and strategy of investigation conceived so to tackle and encounter the research problem more efficiently and accurately. It seeks to obtain answers to research
questions or objectives more efficiently and to control variance.

There are number of experimental designs as mentioned in caption 4.2. From all these designs the investigator decided to adopt 'Pre test - post test control group design'. The pre test - post test control group design was considered most suitable to the present experiment. The present investigator formed four homogeneous groups. Groups were matched on the basis of scores on two standardized tests. Pre test (criterion test) was administered to each group before the treatment given by particular instructional media. After completion of treatment post test (criterion test) was administered. Groups exposed to three treatments were called experimental groups. Group exposed to the traditional method of teaching was called control group. Mutual contact and interaction of these groups were avoided as far as possible. Finally, scores obtained from pre test and post test were subjected to analysis so as to judge the efficacy of the particular instructional media. The outline of the design of experiment is as follows.
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4.7 Technique of analysis

For a better and sophisticated analysis of available data, the technique of analysis of covariance (ANCOVA) was used. To support this 't' test was also applied. Significance of differences among adjusted Y means was also studied. Smoothed cumulative percentage curves (ogives) were plotted for comparison. The comparison between the means on criterion scores of all the treatments was the criterion to judge the efficacy of the experimental
group. In the present investigation, groups were not matched on the entering behaviour but they were matched on scores of two standardized tests. So analysis of covariance technique was used, using pre-test results on criterion test as a covariate. The analysis of covariance is able to test the null hypotheses and to give a quantitative picture by making it possible to see at which level the difference exists. A final step in analysis of covariance permits one to adjust the criterion means to compensate for initial differences between the groups. So, after analysis of covariance applied to different groups, adjusted means were obtained. Significance of differences among adjusted Y means was studied. On the basis of this efficacy of the instructional media was judged.

The next chapter deals with the details of the procedure followed in conducting the experiment.