
UNIT 13 EXPERIMENTAL METHOD

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13.0 OBJECTIVES

After reading this Unit, you will be able to:

- understand the basics of experimental method;
- know the definitions of parts of experiments;
- get acquainted with the steps in planning experimental method; and
- understand the importance of experimental design.

13.1 INTRODUCTION

Webster's Dictionary states the meaning of the term experiment as:

- trial made to confirm
- to disprove something
- operation undertaken to discover some unknown principles or effect
- to test some suggested truth
- to demonstrate some unknown truth
- conducting of tests.

These points emphasise the seriousness of the experimental process to find out the truth. Further Greenwood elaborately describes that "An experiment is the proof of hypothesis which seeks to hookup two factors into a causal relationship through the study of contrasting situations which have been controlled on all factors except the one of interest, the latter being hypothetical cause or hypothetical effect".

Experimental research is one of the basic methods of research specifically in the field of physical sciences. This is useful for tracing the cause and effect relationships. Normally experiments are carefully planned and conducted to record the results through observations under controlled conditions.

It involves independent and dependent variables. It aims to study the effect of an independent variable on a dependent variable. Experimental approach provides an answer as to why certain phenomenon occurs or what happens if a particular factor is changed.

Why we need Experiment?

Experiment requires special efforts. It is often difficult to design and also it is time consuming. So the question arises why one should take such a trouble? Why not simply observe/survey the phenomenon? The fundamental weakness of any non-experimental study is its inability to specify the cause and effect. It can only show correlation between variables but correlation alone never prove causation. Experimentation is the only way which can show the effect of an independent variable on dependent variable. In experimentation, the researcher can manipulate the independent variable and measure its effect on the dependent variable. Moreover, experiment provides the opportunity to vary the treatment in a systematic manner.

Experimental Method in Social Sciences

There is a question on the possibility of conducting experiment in social sciences as comfortably as in the case of physical sciences. It is true that the experimentation in social sciences is not as effective as physical and chemical sciences. In physical and chemical science the experiments can be repeated endlessly under controlled and practical conditions. Where as in the case of social sciences it is impossible to repeat the experiment under varied conditions. Though true experimentation in social sciences may be of minor importance, the recent developments in the application of statistical methods to social problems have brought-in enormous changes.

Experimental method connotes laboratory situation. How it is possible for social scientists to bring a piece of society in to the laboratory? And how to observe its behaviours in a test tube under varied conditions? If it is true, then the question comes does the astronomer bring the solar system in to the laboratory?

Though this kind of controversies are still prevailing, the research techniques and tools have improved considerably to tackle the issues. Hence, the fast development of scholarship in social sciences on the strong footings of scientific method.

13.2 RESEARCH PROBLEM APPROPRIATE FOR AN EXPERIMENT

Experimental research in library and information science covers areas such as testing of new tools and techniques for developing, designing, maintaining and utilising the total collection of the library. It is also possible to identify inadequately conceived ideas, until not known or not observed phenomena along with exploring the conditions under which certain phenomena occur in library and information science. The growth and development of the library over a period of time is revealing the fascinating changes that have occurred from time to time. Understanding of these changes and their implementation in different situations, naturally leads to explore newer experimental research approaches.

13.3 PARTS OF AN EXPERIMENT

It is essential to know here the parts of experiment to understand better the process of experimental research. Some of the identified parts of an experiment are subject, experimental group, control group, treatment, independent variable, dependent variable, pretest, posttest and random assignment.

Variable

A variable is a changeable element in phenomena. Variables are divided in to two types;

Dependent Variable

Independent Variable

- **Independent Variable**

is an experimental variable, which is manipulated in an experiment it is also known as causal variable.

- **Dependent Variable**

is a subject variable associated with control group. This is also known as effect or criterion variable.

Experimental group

The subjects who are randomly assigned to get the treatment are called experimental group.

A treatment

A treatment is the condition that is applied to experimental group of subjects. In the case of library and information science treatment covers the facilities developed to provide more easy access to the scattered information in the form of an index, catalogue, bibliography, current awareness lists and abstracting services. Even user education and information literacy programmes can be considered as the treatment aspects.

Random assignment

In an ideal experiment all the factors that might affect the outcome of the experiment (the dependent variable) are controlled by the experimenter. This is more possible in the case of natural sciences where as in social sciences, complex subjects matters pose the problems of identification of variables and their control. Therefore, to overcome this problem the concept of randomisation is used. This randomisation is nothing but assigning subjects to experimental and control groups at random. Random assignment is a requirement of statistical tests of the significance of experimental results.

A subject

A Subject is a basic unit on which the experiment is conducted. This varies from discipline to discipline. In the case of library and information science or for that matter social sciences subjects are often people – patrons, librarians or users.

Control Group

Control is central to experimental research. This helps in distinguishing the experimental research from other methods of research. Control group is that on which the experiments are not conducted. Control group helps in the process of comparison. Even the treatment is not applied to control group.

Cause and effect relationship

The results of the experiment showing the influence of manipulating the independent variable (cause) on the dependent variable (effect).

Pretest

The measurement of dependent variable after the random assignment of subjects to experimental group and control group is called pretest.

The measurement of dependent variable for experimental and control groups after the pretest and introduction of treatment is called posttest.

13.4 STEPS IN PLANNING AN EXPERIMENTAL RESEARCH

Experimental research is to be planned carefully considering all the details so as to obtain the best possible results from the experiment. The experimenter is supposed to bear in mind the following steps while planning the experimental research.

Selecting the Problem

Selection of the problem suitable for experimental method has to be done very cautiously. The elaborate study of the literature related to the field and the successful application of experimental method for the collection of data will give good insight. Another factor is that the possibility of manipulating independent variable to study its effects on the dependent variable has to be cautiously decided. It is true that all problems cannot be approached through the experimental research. Therefore, only such problems which are amenable for experimental research are to be taken for investigation. In the case of library and information science problems like compatibility of different indexing systems, classification codes and also methods of innovative teaching to enhance the performance among the library and information science students can be the best examples to be tackled through experimental research.

The selection of the problem is followed by the formulation of hypothesis, with conceptual clarity and fixing of the place, time, duration and materials for the experimentation. Further, proper attention is paid in deciding the subjects and groups on which the experiment is going to be conducted.

Selection of Setting

Experiment in the laboratory environment will have an automatic setting, where as in the field experiment environment natural setting has to be selected. Usually the important factors that are to be considered for a good setting are as follows:

- the environment conducive to the phenomena be studied;
- the phenomena must occur in the setting so that organising the experiment is possible;
- the researcher has to have all skills and techniques to manipulate independent variables as well as the knowledge of controlling the other factors which might come in the way of experimentation; and
- there should be enough freedom for the researcher to access and publish the data.

Pilot Study

The pilot study is a pre-requisite in all serious research activities to find out the realities. It gives an idea to the researcher to understand and clarify number of doubtful factors involved in the experiment. As a result the experimenter will be in a sound position to conduct the experiment and convince the authorities as far as the successful conducting of experiment is concerned.

Research Design

This is a rough layout of the total structure of the experimental research. Research design involves enumerating the independent and dependent variables and gives the direction to the researcher to manipulate the situation. Further, research design also

helps in selecting control groups, experimental groups, random assignment of subjects to eliminate the personal bias and problem of choice and also measurement of the effect manipulation of independent variable, repetition of experiments to confirm, etc.

Conducting the Experiment

The following are the important steps normally used in conducting the experiment:

- controlling the variable or non-experimental factors;
- manipulating the independent variable;
- measurement of experimental results;
- analysing, classifying and interpreting the findings;
- cross checking the findings with the existing facts;
- drawing conclusions from the findings; and
- reporting the results.

Evaluation of an Experiment

Evaluation forms an important component in experimental research. The evaluation consists of hypothesis(es) testing, identifying the experimental error, sensitivity, internal validity and external validity.

Experimental research usually starts with the formulation of null hypothesis and testing the same. Null hypothesis asserts that within the specified limits of credibility the control and experimental groups are essentially equivalent. A test of null hypothesis intends to show that the experimental variable has not effected any change in the value of dependent variable. For the purpose of testing a null hypothesis, the tests like T tests, Chi-square test and analysis of variance are used according to the need.

The sensitivity of an experiment is its ability to detect relatively small effects. To increase the sensitivity of an experiment the investigator increases the number of subjects.

The experimental error is decreased by exerting additional control over the experiment. This is achieved by matching subjects on the basis of as many variables as possible.

The internal validity of an experiment is mainly estimated through answering the questions like: i) Are variables sufficiently controlled? ii) Has random assignment of subjects been employed throughout?

The external validity of an experiment is tested by answering the questions like: i) Can the results of experiments be generalised? If so, what is the population to which it can be generalised? ii) When a sample is taken, to what extent sample is repetitive for the target population.

Justification of the generalisation is easier in the case of field experiments. Because of the artificiality, the generalisation can hardly be justified in the laboratory experiment environment.

To conclude, the evaluation of experimentation findings is always in terms of reliability of the data, importance of experimental results and the extent to which the data can be generalised.

13.5 LABORATORY EXPERIMENT AND FIELD EXPERIMENT

An experiment can be defined as a form of experience of natural facts that occur following deliberate human intervention to produce change, as such it distinguishes

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itself from the form of experience involving the observation of facts in their natural settings. This definition leads to think of two distinct types of experimentation. They are laboratory experiment and field experiment.

Laboratory Experiment

A laboratory experiment is an investigation conducted in a setting created specifically for the purpose. Here the researcher manipulates an independent variable and studies its effect on a dependent variable, keeping other variable constant.

Purpose of Laboratory Experiment

The main purposes of laboratory experiment are:

- to discover causal relations under uncontaminated conditions;
- to test the predictions derived from theory and other researches; and
- to refine theories.

Users of Laboratory Experiment

This method is useful not only in physical science research, but also in social science research. Even though experimentation on a social science problem has special difficulty, it can be used for a variety of problems. Studies such as information seeking behaviour, and use of specific types of documents, etc., can be approached through this method.

Merits of Laboratory Experiment

Laboratory experiment has several merits as listed below:

- It has the possibility of securing relatively complete control over extraneous factor(s);
- It can manipulate one or more variables and can study its impact on dependent variables;
- High degree of specificity can be achieved in operationalising the variable; and
- It yields precise results and it is replicable.

Demerits of Laboratory Experiment

- The greatest weakness of this method is probably the lack of strength of independent variables. Because, laboratory situation is artificial, so the effects of experimental manipulation are usually weak.
- This method is highly structured, thus limiting flexibility
- The results cannot be simply generalised to real life situations because various extraneous forces operate in the latter stage.

Field Experiment

This is an experiment conducted in a real life situation in which the experimenter manipulates an independent variable in order to prove the experiment. In comparison with laboratory experiment, a field experiment involves less control, because it is very difficult to foresee and control extraneous factor in the field.

Uses of Field Experiment

This is well suited to both testing of theory and finding solutions to practical social problems. It is useful for studying variety of social action programmes such as improving the work culture, productivity and increasing the efficiency in the professional performance.

The field ‘experiment will be more successful if preceded by a field study which gives a more thorough knowledge of the setting.

Merits of Field Experiment

Field experiment has several merits as listed below:

- The variables in a field experiment usually have a stronger effect than those of laboratory method, as the field situation is real. Realism increases with strength of the variable.
- This method is particularly appropriate for studying methods of social influence, social processes and social changes in real life setting.
- As this deals with the total life situation it is well suited for studying complex syndromes and social processes where inter-relationship among many analytical variables are involved.

Demerits of Field Experiment

- The major demerit of this method is the practical difficulty involved in the manipulation of independent variables and randomisation in many fields.
- Another weakness is the lack of precision, precise measurement in realistic situation is not possible as in laboratory method.

Self Check Exercise

1) Differentiate between the Laboratory and Field Experiments

- Note:** i) Write your answer in the space given below.
 ii) Check your answer with the answers given at the end of the Unit.

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13.6 EXPERIMENTAL RESEARCH DESIGN

‘Necessity is the mother of invention’, thus goes an adage. An inquisitive mind is always trying to search for new things. Then the feeling of need, identifying the deficiency and attempting to improve the situation all contribute to create the experimental attitude which is required for experimental research.

An experimental design involves two groups of subjects. Of these, one is the control group, which is not subjected to experimentation, while the other is the experimental group on which experiments are performed. At a time, a single variable is added in the case of the experimental group to check if its presence produces a change in the condition of this group. The operative rule of experimental design is to vary one circumstance at a time maintaining all other circumstances unchanged. This is known as the law of the single variable, which has to be satisfied in every experimental design to establish cause and effect relationship. Thus, adequate control is the essential factor of the experimental method of research. An experimental design is prepared to include the following elements:

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- A problem that can be solved;
- Experimental factors;
- The best type of set-up for experimentation;
- The operative rule, i.e. the law of the single variable;
- Measurement programme;
- The experimental design concerns the technical and organisational features, which define the experiment - the number of experimental groups, the way in which the groups are made, number and types of independent variables, any repetition of observations, etc. Such characteristics may vary greatly and when combined give rise to a multitude of possible experimental designs;
- In experimental design, experts have categorised four distinct designs which are as given below:
 - Before – After or Pre test experimental design;
 - After only or Post-test only experimental design;
 - Quasi – Design or Post-facto experimental design; and
 - Special design or Mixed design.

Before-After or Pre- test- Post-test Experimental Design

This is normally called classical experimental design. It is more reliable and it represents the so-called four-cell design (Fig. 13.1). Here, before experimentation all the groups are selected, observed and measured. There is one independent variable - the treatment - and one dependent variable. Subjects are assigned randomly to the control group and experimental group. Then the dependent variable is measured for both the groups. After pretest, the treatment is introduced to the subjects in the experimental group only. The dependent variable is then measured again for both the groups and compared. This is the Post- test. This design suffers from one limitation, that is, it does not ensure to be free from the influence of external factors.

	Value of Dependent Variable Before Treatment	Value of Dependent Variable After Treatment
Control Group		
Experimental Group		

Fig. 13.1: The Four-Cell Experiment Design

After-only or Pre-test only Experimental Design

In this type of design the study is carried out under social conditions, which are not at all in the control of the physical or natural conditions. Two groups of subjects, who are similar in all conditions, are chosen. One is called experimental group and the other is called control group. Experiment is carried out on the experimental group as per the

pre-determined method. After the prescribed period both groups are observed and the results are measured. The results are compared and changes that are observed in the experimental group are recognised as a result of manipulating the variable in the experiment.

Quasi or Ex-Post Facto Experimental Design

The name of the quasi experiment has been given to those situations in which the experimenter cannot randomly assign subjects to experimental groups, but can still manipulate the independent variable. However when even such manipulation is impossible - that is to say, when the stimulus is also beyond the control of the researcher – we can no longer speak of experimentation, what we have is purely and simply, an analysis of co-variation. Never the less there are research situations which, although lacking both features of experimentation (i.e. randomisation and manipulation) involve a design that closely resembles that of experimentation. Such designs are called *ex post facto*.

‘*Ex Post Facto*’ is a Latin phrase which means ‘done or made after a thing but retro action upon it’. In this the experimenter does not achieve the change which studies, he invariably chances upon the effect after it has already occurred. In Library Science, children reading habits and behaviour of a fresh reader in the library can be studied with the application of this design.

Special design (Mixed Design)

There is a special design called multifactor - between subjects design (also called mixed design). Where one factor is between and the other is with-in. This design demands as a pre-requisite, computer programme and the statistical consultant. This kind of mixed designing is used in a situation where the experimenter:

- needs power;
- wants to generalise the results to real life situation where people are bound to get more that two levels of the treatment; and
- feels that order effects are not a problem.

Self-Check Exercise

2) Enumerate the different experimental designs.

Note: i) Write your answer in the space given below.

ii) Check your answer with the answers given at the end of the Unit.

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13.7 ADVANTAGES, DISADVANTAGES AND LIMITATIONS OF EXPERIMENTAL METHOD

Experimentation has two basic advantages; firstly it is the research method that best enables us to tackle the problem of the causal relationship; secondly it allows isolation of specific phenomena, which could not be studied, systematically in their natural setting, owing to the presence of other factors that hide, confuse and distort them.

Advantages

- Its power to determine causal relationship is much better than that of all other methods.
- The influence of extraneous variables can be more effectively controlled.
- The element of human error is more reduced.
- More conditions may be created and tested in this method.
- This method yields generally exact measurements and it can be repeated.

Disadvantage

- It is very difficult to establish comparable control group and experimental group.
- The scope of experimentation with human beings is extremely difficult.
- Experiment is often difficult to design as it tends to be expensive and time consuming.
- Experimentation can be used only in studies of the present but not in studies relating to the past or future.

Limitations

- Experimentation is applicable to certain phenomena and certain social situations.
- Experimentation cannot be conducted if the independent variable cannot be manipulated.
- This approach is generally suitable to ‘micro’ issues (involving interpersonal relationships) rather than to ‘macro’ situations (on account of the difficulty of manipulating institutions or social groups).

Self-Check Exercise

3) State the advantages of experimental method.

- Note:** i) Write your answer in the space given below.
ii) Check your answer with the answers given at the end of the Unit.

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13.8 SUMMARY

We have seen so far a brief description of experimental research method and its different aspects. The use of experiment to collect the data for testing the hypothesis(es) is a hallmark of research in physical and chemical sciences. The literature review reveals that there is an increasing application of experimental method in recent years in library and information science research.

Experimentation is a social research technique well suited for specific issues, group analysis and dynamics of interaction among individuals and all those phenomena that occur in limited segment of space, time and number of persons involved. Cause – effect relationship is the very basics of scientific reasoning. In social science, experiments can be sub divided into laboratory experiments and field experiments, in the first case the experiment is carried out in an artificial situation, where as in the second a real life setting is used. Laboratory experiments can be classified in to impact studies, judgements studies and observational studies.

Four cell experimental design is a popular design in the field of research. Generally identified experimental designs are:

- Before – After or Pre test experimental design;
- After only or Post-test only experimental design;
- Quasi – Design or Post-facto experimental design; and
- Special design or mixed design.

13.9 ANSWERS TO SELF CHECK EXERCISES

- 1) The difference between Laboratory experiment and the field experiment is simple. Usually the laboratory experiment is conducted in an artificial situation. Where as the field experiment is carried out in a real-life setting.
- 2) Before – After or Pre test experimental design
 After only or Post-test only experimental design
 Quasi – Design or Post-facto experimental design; and
 Special design or Mixed design
- 3) Advantages:
 - Its power to determine casual relationship is much better that that of all other methods
 - The influence of extraneous variable can be more effectively controlled
 - The element of human error is more reduced
 - More conditions may be created and tested in this method
 - This method yields generally exact measurement and it can be repeated.

13.10 KEYWORDS

Variable	: The treatment variable
Null Hypothesis	: Hypothesis, that there is no evidence that the treatment has an effect
Experimental Hypothesis	: A prediction that the treatment will cause an effect
Randomisation	: A tool used to establish internal variability
Mixed Design	: A special design where one factor is between and the other is within.

13.11 REFERENCES AND FURTHER READING

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