DRAFT TRAINING PACKAGE ON ACTION AND EXPERIMENTAL RESEARCH

DR. U. LAKSHMINARAYANA
Academic Co-ordinator

TEAM MEMBERS

Dr. D. BASAVAYYA
Mr. A.C. JOCY
Dr. A.S.N. RAO SINDHE
Dr. V.D. BHAT

REGIONAL INSTITUTE OF EDUCATION
(NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING, NEW DELHI)
MYSORE-570 006

1999

LIST OF RESOURCE PERSONS

1. Prof. N. Venkataiah
   Professor in Education
   University of Mysore
   Mysore-570 006

2. Prof. S.C. Sarma
   Professor in Education (Rtd)
   Andhra University
   Visakhapatnam

3. Prof. K. Ramachandra
   Professor in Education
   Karnataka University
   Dharwad-580 001

4. Prof. A.V. Govinda Rao
   Principal
   Somani Institute of Education
   Mysore

5. Dr. Y.N. Sridhar
   Principal
   R.I.M.S.E.
   Yadavagiri
   Mysore-570 020

6. Dr. G. Viswanatham
   Sr. Lecturer in Education
   Annamalai University
   Annamalainagar

7. Dr. D.V.V. Krishnam Raju
   Vice Principal
   D.N.R. College of Education
   Bhimavaram-534 202

8. Mr. R. Gopal
   Lecturer in Psychology
   D.I.E.T.
   Karmamnikuppam
   Pondicherry-605 004

9. Dr. R. Devanathan
   Reader
   IASE
   R.S. Vidyaputham
   Tirupati-517 507

10. Mr. Kumara Swamy
    Officer Incharge
    ELTC, Vasanthamahal
    Nazarbad
    Mysore-570 010

CONTENTS

MODULE 1

CONCEPT OF ACTION RESEARCH

Objectives

After reading this module you would be able to understand,

1. the steps in action research
2. the characteristics of action research
3. the objectives of action research
4. the advantages of action research
5. the limitations of action research, and
6. the difference between action and fundamental researches.

Research can be classified under three broad categories; basic or fundamental research, applied research and action research. It must not, however, be forgotten that the lines of demarcation between these categories are not very clearcut and sharp. In many ways they appear to overlap one another.

Action research is similar to applied research in many ways. The only difference can be that applied research may be carried out on a larger sample resulting into more universally applicable findings. As against this, action research will primarily be conducted on the immediately available small sample in order to solve the immediate

problem for the same group. Applied research may quite often be carried out by experts whereas action research is primarily the concern of the field workers.

Action research is undertaken by educational practitioners because they believe that by so doing they can make better decisions and engage in better actions. The teachers, supervisors and administrators would make better decisions and engage in more effective practices. The process by which practitioners attempt to study their problems scientifically in order to guide, correct and evaluate their decisions and actions is what is called action research. A teacher conducts action research to improve his own teaching. A school administrator conducts action research to improve his administrative behaviour.

This research represents an approach to be more disciplined, more objective and more scientific. It has procedure that tries to keep problem solving in close touch with reality at every stage. It is focussed on the immediate application not on the development of theory. It is concerned with the immediate problem here and now in a local setting.

The scope of action research is very vast. This approach of dealing with practical problems seems to be appropriate and promising for all kinds of professional workers in education so long as their desire is to improve their own professional practices. An administrator who is

dissatisfied with his efforts to develop a high morale in his staff could approach this problem with action research.

STEPS IN ACTION RESEARCH

1. Identification of the problem area.
2. Selection of a specific problem.
3. Formulation of hypotheses problem.
4. Careful recording of action taken.
5. Accumulation of evidence to determine the degree to which the goal has been achieved.
6. Inference from their evidence of generalisation regarding the relation between the action and the desired goal.
7. The continuous retesting of the generalisations in other action situations.

ACTIVITY 1

List out some problem areas.

1.

2.

3.

ACTIVITY 2

List out specific problems with which you are encountered during classroom transaction.

1.

2.

3.

ACTIVITY 3

Select one specific problem and formulate hyptheses.

1.

2.

3.

ACTIVITY 4

Write the actions you are proposing to bring out desired changes.

1.

2.

3.

ACTIVITY 5

Write the procedures of recording the change

1.

2.

3.

CHARACTERISTICS OF ACTION RESEARCH

1. It is scientific and tries to find out solution for current problems.
2. It modifies the personal research or clinical.

3. Practical problems of education can be solved through this.
4. The focus is to improve and modify the current practices because the researcher can only study his problem.
5. Both individual and group problems are taken up by action research.

OBJECTIVES OF ACTION RESEARCH

1. Improvement of the working conditions of educational institutions.
2. Development of democratic atmosphere in the class room for understanding and solving problems.
3. Bringing excellence in school workers.
4. Developing understanding among administrators to improve and modify the school conditions and making it more conducive to learning.
5. Making the school effective and developing a congenial environment for student learning.
6. Raising the level of aspiration of the students.

ADVANTAGES OF ACTION RESEARCH

1. The approach is experimental and tentative rather than dogmatic.
2. An integral part of action research is the experiment which actually is change valuated.
3. It emphasis a durable decentralisation of decision making and action.
4. It is used for the improvement and solving the current class room problems of a teacher.

5. The problems can be solved quickly.
6. The solutions of the problems are put in practice and evaluated.

LIMITATIONS OF ACTION RESEARCH

1. It is at low key.
2. It is an unduly localised research effort. The generalisations cannot acquire a universal validity. The applicability of findings to another class and another school is quite doubtful.
3. It may become an additional burden on an already overburdened teacher.
4. Because of numerous limitations, it may produce wrong and unverifiable conclusions.

DIFFERENCE BETWEEN
ACTION RESEARCH AND FUNDAMENTAL RESEARCH

Aspects	Fundamental Research	Action Research
OBJECTIVES	Its purpose is to develop and test educational theories and to obtain universally applicable principles.	Knowledge obtained is intended to be applied in local setting. It also provides a sort of inservice training to participating field workers.
EXPERTISE	Expert training is needed in measurement, research methodology and statistics.	Only an ordinary training may suffice. Action research can be done by an average teacher under the guidance of a consultant.
LOCATING THE RESEARCH PROBLEM	A wide range of methods and a vast process is used to locate the research problem.	It deals with the problems which hinder class room teaching-learning process. Thus the participating teachers can easily identify them.
INVOLVEMENT	A research worker may not be personally involved in the problem he selects for the research.	The teacher is invariably involved in the research problem.
HYPOTHESES	Highly specific and well stated hypotheses are formulated and adopted.	Only the specific statement of the problem services as a hypotheses.
REVIEW OF LITERATURE	It necessitates an exhaustive and thorough review of literature in order to have a complete understanding of the accumulated knowledge in the area.	It demands simply a general understanding of the area. There is no need for a thorough and intensive review.

Aspects	Fundamental Research	Action Research
SAMPLING	A random or otherwise unbiased sample of the population is studied.	Pupils studying in the particular class taught by the teacher are used as subjects.
DESIGN	Careful attention is paid to maintain comparable conditions thus reducing error and bias.	Procedures are planned only in general terms.
ANALYSIS OF DATA	Complex analysis is often called for.	Simple procedures for analysis are considered sufficient.
STATISTICAL TREATMENT	There is stress on befitting statistical treatment of date for the sake of objectivity.	Not much stress on objectivity and statistical treatment. Even the subjective opinion of participating teachers is given weightage.
APPLICATION OF RESULTS	The research findings usually remain confined to research reports and publications. There is no coordination between the research workers to ensure utilisation of valuable conclusions.	Findings are applied straight away to the classes of partici-pating teachers and lead to far-reaching improvements in the teaching learning process.

MODULE 2

EVOLUTION OF ACTION RESEARCH

Objectives

After reading this module you would be able to

1. appreciate the role of teacher as a researcher
2. appreciate the naturalistic and practical perspective
3. understand qualitative methodology
4. understand the historical background of action research, and
5. appreciate the collaborative action research for professional development

The rationale for action research is based on following three premises.

1. Naturalistics settings are best studied and researched by those experiencing the problem.
2. Behaviour is highly influenced by the naturalistic surroundings in which it occurs and
3. Qualitative methodologies are best suited for researching naturalistic settings.

Teacher as researcher

The assumption that naturalistic settings are best studied by those experiencing the problem, leads to the fact that teacher must engage in some kind of research to improve

his classroom practices. This form of research is a self-critical inquiry. But most of the teachers and administrators depend on external professionally trained researchers to seek solutions to their problems. Teacher as researcher is a recent concept derived from naturalistic, field or case study paradigm of research. This concept has emerged mainly due to the failure of basic research in suggesting solution to the problems of classroom practices and learning.

The present status of action research has came into being as a result of problems met by teachers in improving their performance. The main emphasis is, now, on improving the quality of teacher action than to formulate theories for action. This concept of teacher as researcher initiated a shift from quantitative research to naturalistic research.

ACTIVITY 1

Think and write the situations where you played the role of a researcher.

1.

2.

3.

The naturalistic and practical perspective

Human behaviour is influenced by the surroundings in which it occurs. Research, if it is carried out in grass-root realities, alone could yield necessary solution to a

practical problems and facilitate a teacher to improve his quality of practice. Research cannot be taken up in simulated settings but to be carried out in natural setting. So behaviour should be studied in the natural setting.

ACTIVITY 2

From your experience list out some natural setting in which classroom research can be undertaken.

1.

2.

3.

Qualitative methodology

The main focus of naturalistic research is understanding and describing rather than measuring and predicting. It refers to investigation of phenomena within and in relation to naturally occurring contexts. Major criticism, then, comes is subjectivity. Hence researcher has to find ways of reducing subjectivity. In qualitative research importance is given to feelings, narration and values of the subjects in natural settings. It allows data to emerge on their own without any preconceived theories or forced structures imposed on the study, and looks for meaning in the events.

Historical background of action research

Kurt Lewin is considered to be the chief proponent of action research. Action research has its moonings in

scientific method. There are some evidences that some social reformists initiated the concept of action research prior to Lewin. It is necessary to understand the evolution of action research and to appreciate the principles and procedures employed in its long history. Action research is in a transient stage of redevelopment. Action research has been influenced by the historical and philosophical flavour of the following:

1. The science in education movement: During of 19th and early 20th century, there are many authors dealing with scientific method applied to education.

2. Experimentalist and progressive educational thought: Dewey applied the inductive scientific method of problem solving as a logic for the solution of problems in such fields as aesthetics, philosophy, psychology and education. His stages of reflective thinking contain all the features of the scientific action research. Teacher involvement in both curriculum research and development became more direct after 1930s. Action research programmes have been implemented by making practitioners identify and solve problems of curriculum design and material production.

3. The group dynamics movement: In the 1940s with the onslaught of war, problems of intergroup relations, social reconstruction and other social problems emerged. In order to solve these social problems, action research has

been considered as a main source. Lewin discussed action research as a form of experimental inquiry based upon the groups experiencing problem. His contribution is important because, although not the first to use and write about action research, he did construct an elaborate theory and made action research respectable inquiry for social scientists.

4. Post-war reconstructionist curriculum development activity: A number of post war social reconstructionist writers emphasised the use of action research in education. Stephen Corey was foremost in leading this movement, and he believed that action research could significantly change and improve curriculum practice because practitioners would use the results of their research investigations. During 1950s action research was used as a general strategy for designing curricula and solving complex problems. This period is considered as era of 'cooperative action research', in that teachers and schools cooperated with outside researchers. Towards the end of 1950s action research was in decline and there was a split between theory and practice. This separation resulted in negative consequence of preventing researchers from studying problems in the field, particularly innovative practices.

5. The teacher-researcher movement: It marks a radical departure from the conventional view of curriculum research as a specialist occupation. Stenhouse (1971)

opined, "that all teaching ought to be based on research and that research and curriculum development are the preserve of teachers; the curriculum then becomes a means of studying the problems and effects of implementing any defined line of teaching. The practitioner gains increased understanding of his or her work and thus teaching is improved".

Collaborative action research for professional development

Action research is considered as a collaborative or interactive style of research involving both internal and external researchers. Lieberman and Miller (1984) opined, 'that in 1970s action research was rediscovered and renamed as interactive research and development'. Collaboration suggests that each team shares in the planning, implementation, analysis and reporting of the research. Hovda and Kyle (1984) perceived action research as a realistic professional development strategy and suggested following plan:

1. Identify interested participants. For example, teachers from one or a number of schools who are willing to join action research.

2. Provide a context for action by discussing questions such as

* What is action research ?
* What are some possible benefits and functions of research ?

* What methods seem appropriate for teachers doing this research ?
* What topics have others studied and written about?
* What methodological and ethical issues need to be addressed ?
* What constraints and limitations need to be acknowledged ?

3. Complete 'trial runs' of topics to provide experience in research and analysis and to help teachers gain confidence.

4. Participants are asked to share several possible study topics which they might employ in their classrooms. Through small and large group discussion, each teacher-researcher selects one problem to research.

5. Each participant identifies an appropriate research method for specific research issue.

6. As each researcher writes a descriptive proposal about the research problem and its methodology, time is needed for the peer-critics to offer advice about where further elaboration or clarification is required.

7. As teacher-researchers develop their studies, time is allocated to the discussion of results, problems, etc.

8. Time is given over to discussion to how best to write the report. Researchers then share the study with pen-critics before a final report is written.

9. Focus final questions on:

* What issues are thrown up by the study ?
* What do the studies let one know about the curriculum ?
* What impact might the study have on future practice ?
* What have we learned about action research as a tool for professional development ?

10. Explore the possibility of leaving the teachers' studies published, presented or shared in some way with other teachers.

MODULE 3

REVIEW OF ACTION RESEARCH COURSES

Objectives

After reading this module you would be acquainted with some action research programmes, such as,

1. the University College of Dublin M.Ed. Centre
2. the East Carolina University's Course in foundation and curriculum development
3. the State University of New York Course
4. the George Mason University M.Ed.in curricular/reflective practice
5. the Dea Kin University E-mail Course
6. the Centre for Action Research in Professional Practice.

Realising the importance of improving quality of teaching in real classroom situations, number of action research programmes are launched in recent times. This is due to the reason that the quality of teaching is a reality, only when classroom practitioners are able to solve their immediate practical problems through research. Yet, very few educationalists addressed the issues and problems of teaching action research. They have specifically addressed the perplexing issues of how to teach the process of action research. During the past decade the trend has been shifted from development of 'theory' to quality, performance,

practice and school based improvements. Now,many educational researchers are spending more time in schools with a view to develop teacher research movement.

Initiatives in teaching action research

Some initiates of teaching action research are presented here under.

1. The University College of Dublin M.Ed. Course

The course has designed as an 'action research seminar'. In this model each of the participants would share responsibility for not only leading one or more seminars, but in making meaningful contributions to the seminar. Participants are required to take two projects - an individual action research project and a whole class action research collaborative project.

The aim of the course was embodied in the principles of procedure outlined for students:

* to conduct action research into real life curriculum problems,
* to study cases of teacher action research, and
* to read for understanding the scholarly literature related to educational action research.

All the students in this course of inservice teachers. There are 13 sessions in this course and every Monday morning for three hours, they used to meet.

The course outline is:

Masters degree: Curriculum development and action research.

Session-1: A short-history of action research: Lewin and scientific developments; Taba's intergroup education project.

Session-2: Basic and applied research.

Session-3: Action research and curriculum development.

Session-4: Case studies of curriculum action research.

Session-5: Action research methods:Obstructive (interactive) and unobstructive (non-interactive) methods of data collection.

Session-6: Action research methodologies continues.

Session-7: Student action research project: Problem selection.

Session-8: Field research seminar: problems, issues and strategies.

Session-9: Writing action research accounts and reports.

Session-10-12: Student action research seminar reports and collaborative meetings with teachers.

Session-13: Action research seminar: Conclusion.

Benefits to post-graduate students

* Students learned about the general notion of social action research and the utility of action research as a teacher application.
* Students were able to employ qualitative methods, eg. case study, diary, journal writing, field note writing, video recording technology.

* Students received credit towards an award-bearing course.
* Students worked in field settings with other professionals and students.
* Students gained ownership of a published set of curriculum material designed by themselves.

Benefits to the schools

The schools involved in cooperating with the university course tutor received new, culturally updated and relevant resource materials for use in their courses with secondary students. Teachers were subjected to a critical review of their social education programmes and some were involved in critical trials of university college Dublin's curriculum development 'travellers unit".

East Carolina University

The title of the graduate course in "Foundations and Curriculum Development". The major aim of the course is 'to promote action research to improve educational practices'. In this course the students are expected to know something about foundation fields of history, philosophy, sociology and curriculum studies, and their relationship to the process of curriculum improvement. Accordingly the course contains curriculum development and student action research experience. The guiding principle is that research promotes the autonomy and professionalism of individual teachers in their work places. The course was first offered to ten masters level education students. The course was seminar-

based and students were expected not only to conduct research projects but to document and report them carefully in the seminars. Student evaluation of the course was extremely favourable.

The information highway action research course

The title of the course is 'Action research in the interactive, distance-learning classroom'. The state-wide system of interactive distance classrooms linked by fibre optic technology enabled teachers and administrators at four locations, in four different school districts, to see and hear each other on video monitors and communicate as if they were in the same room. This is a five week, ten hour staff development course plan focused on one step in the action research cycle per session. The steps are as follows:

1. Loving the questions (problem statement)
2. Lifting the veil (data collection)
3. Living the answers (action plan)
4. Taking the plunge (implementation of the action plan) and
5. Collaborative action research.

Course participants discussed and developed their own action research projects during the course. Participating teachers appreciated the convenience of attending the course within their own district and also the opportunity to interact with teachers from other districts.

State University of New York Course

The aim of this course was "to engage participants in the practice of conducting action research as well as in the study of action research theory and scholarship". This course had a combination of strong theoretical knowledge and personal field research work. The first half of the course was devoted to the process of doing action research and second half of the course examined the scholarly literature.

George Mason University M.Ed. in Curriculum/ Reflective Practice

The university offers a novel teacher research M.Ed. degree, using causes interwoven across semester and work experience.The aim of this course is to achieve intellectual integration and establish teachers as researchers. The two year course begins with a summer workshop with a focus on the teacher in the workplace. The degree seeks to further action research by teachers recruited from schools. The programme starts with a two week workshop leading to four full day's work each semester, for each year coupled by a second summer week workshop and a final third summer week workshop. Students spend time working individually and with the team in school on a teacher research agenda.Participants record a journal throughout the programme and afterwards.

Deakin University E-mail Course

This university offers an electronic mail course at graduate level. The course structure is mixed mode,featuring

student and staff interaction using E-mail and employing published Deakin course materials. Students interact with one another as a participatory action research project in their own work setting. Course assessment is through a series of written assignments, with students submitting assignments to an E-mail "Participatory Action Research Course Journal".

Centre for Action Research in Professional Practice

This centre at University of Bath, Englan, offers a part time post-graduate programme leading to either a diploma, master, or doctor of philosophy degree. It is designed for professionals in education, management and other fields. The objectives of the programme are to:

* learn the theory and practice of action research
* develop the ability to be reflective in the midst of action
* explore the epistemology of research
* develop reflexive learning capacities

Each student joins a small supervision group of three to four members and one faculty member in which they receive support for their research work. Teaching and learning takes place in seminars, workshops and supervision groups.

MODULE 4

MODELS OF ACTION RESEARCH

Objectives

After reading this module you will be acquainted with,

1. scientific action research models
2. practical-deliberative action research models, and
3. critical-emancipatory action research models

Models of action research process are classified into three types. They are -

1. Scientific action research,
2. Practical-deliberative action research, and
3. Critical-emancipatory action research.

It is necessary to describe principles of procedure for conducting action research in these models. The chief concern here is with the manner or conduct, rather than the matter or content of action research.

Scientific Action Research

The scientific action research applies scientific method in solving practical classroom problems. The important models in scientific action research are proposed by Lewin and Taba. Let us examine these models of action research.

Lewin's model

In this model, action research is composed of a series of action steps including planning, fact-finding, execution and analysis. Planning starts with a general idea

or a difficult problem requiring solution. This is followed by further fact-finding or 'reconnaissance', resulting in an overall plan of how to solve the problem. This planned action is implemented and monitored in an attempt to evaluate the effectiveness of the first action step, to plan the next step and to modify the overall plan. The researcher then spirals into developing further action steps leading to further planning, implementation, evaluation and decision-making. This model of action research consists of a series of spiralling decisions, taken on the basis of repeated cycle of analysis, reconnaissance, problems conceptualisation, planning, implementation of action and evaluation of effectiveness of action. This model is shown in Fig. 1.

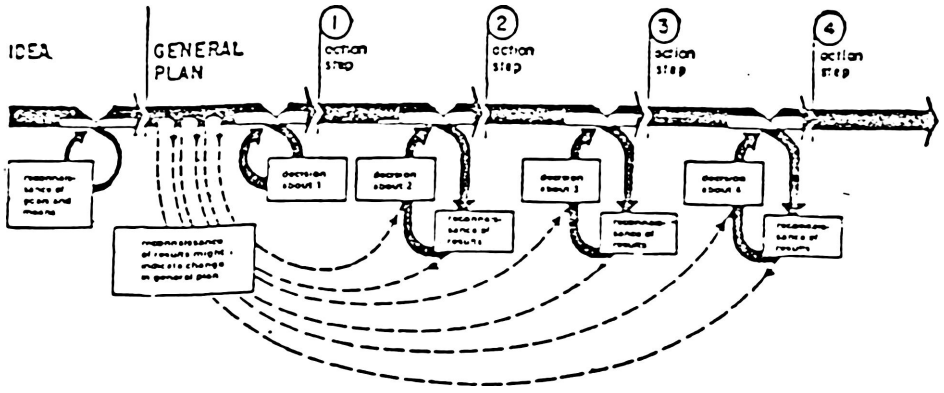


Fig. 1: Lewin's action research model
(Source: Lewin, 1947)

Lewin opines that action research should be in group participation through democratic processes based on careful planning,analysis, fact-finding and evaluation in systematic scientific rational methodology.

ACTIVITY 1
General idea/problem requiring solution:
Plan/action steps:
Implementation:
Evaluation of effectiveness of action:

Taba's Model

In this model the action research process is outlined into following stages:

1. Identification of problems,
2. Analysis of problems,
3. Formulating ideas or hypotheses,
4. Gathering and interpreting data,
5. Implementation-action, and
6. Evaluating the results of action.

ACTIVITY 2
Problem:
Hypotheses:
Data gathering:
Action implementation:
Evaluation of results:

Practical-Deliberative action research

In practical action research, the classroom practitioners tries to understand their practices and solve their immediate classroom problems. For this, a classroom researcher is supposed to undertake different action steps for further evaluation and experimentation to exploit the action process fully. There are two important models in this type of action research. They are Elliott and Ebbutt models.

Elliott's Model

There are three cycles in this model. The steps in first cycle are - identification of initial idea, reconnaissance, general plan followed by action steps, implementation, monitor implementation and effects, and explain any failure in implementation and effects. Basing on the feedback obtained in cycle one, the second cycle starts with revision of central idea, amending plan followed by action steps, implementation of changed action steps, monitoring implementation and effects and reconnaissance. If there is a failure third cycle will start in similar lines.

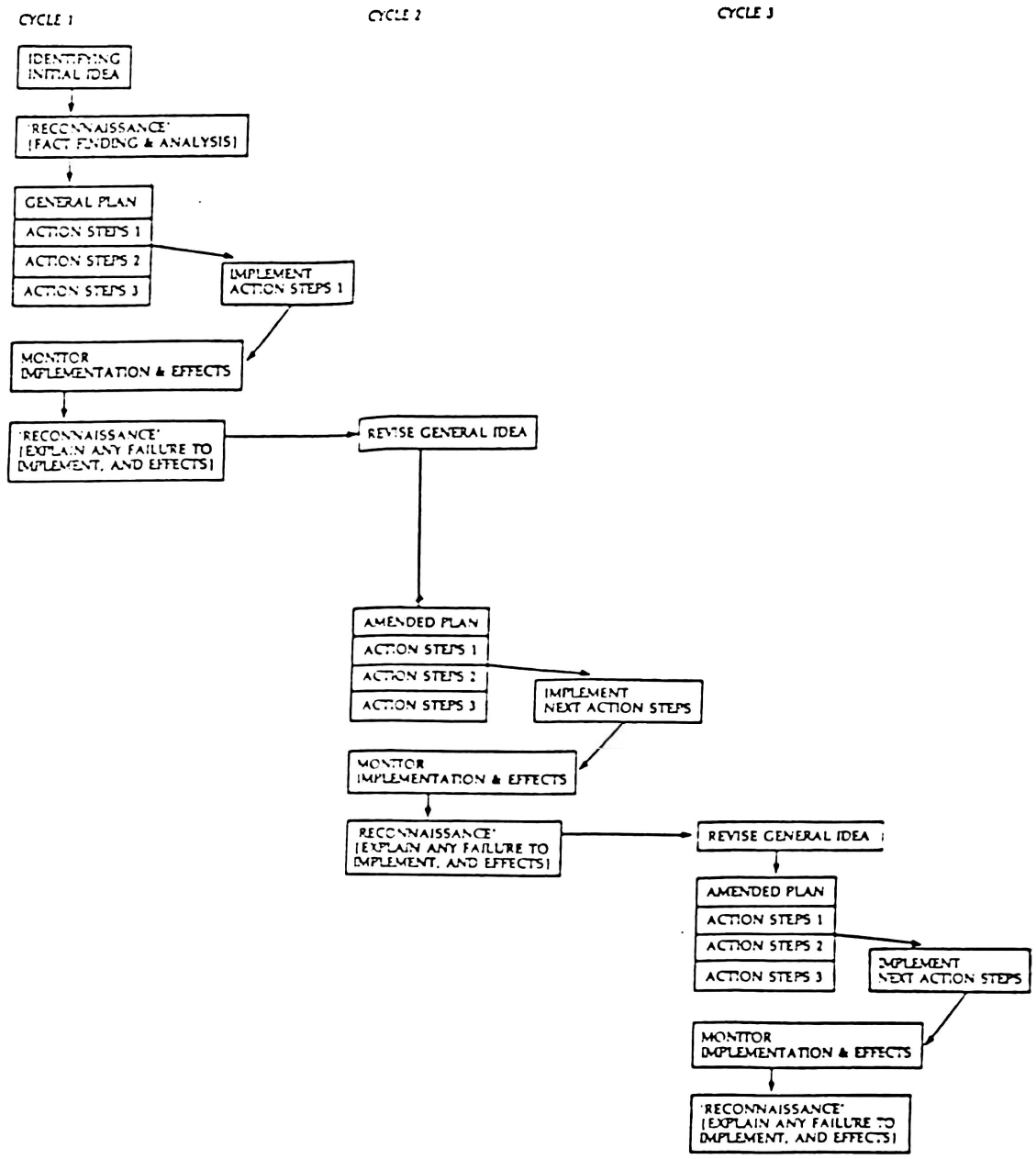


Fig. 2: Elliott's model of action research process
(Source: Elliott, 1981)

ACTIVITY 3

Cycle 1

Initial idea:
General plan:
Effects:

Cycle 2

Revised idea:
Amended plan:
Effects:

Cycle 3

Revised idea:
Amended plan:
Effects:

Ebbutt's Model

Action research process, in this model, is viewed as a series of successive cycles, each incorporating the possibility of providing evaluative feedback within and between the cycles of action.

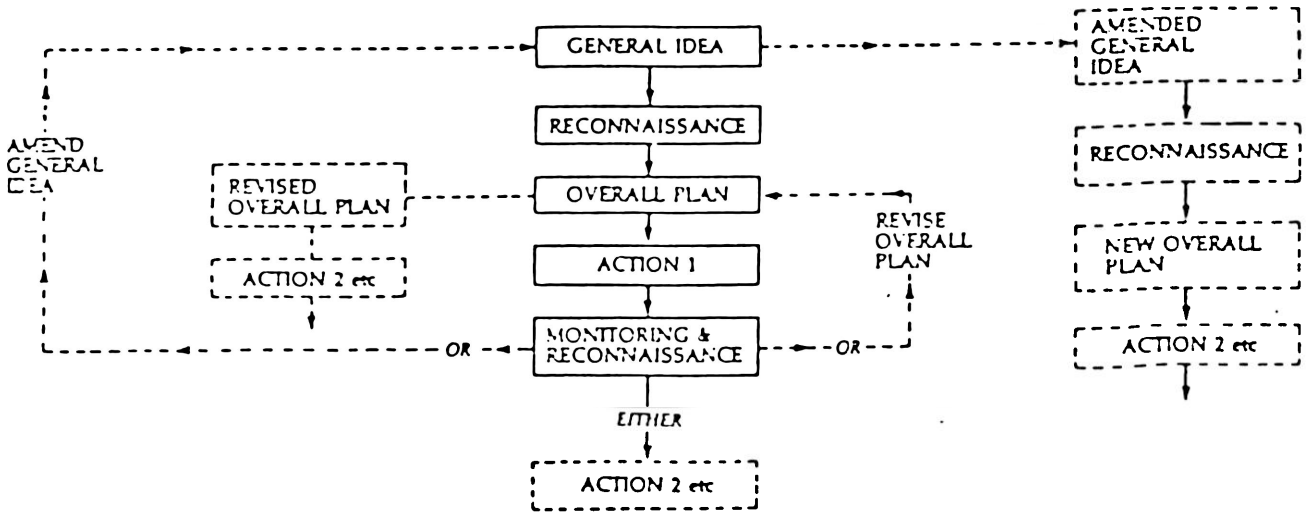


Fig. 3: Ebbutt's action research model
(Source: Ebbutt, 1983)

ACTIVITY 4

General idea:

Action plan:

Conditions under which general idea to be amended:

Conditions under which action plan is to be changed:

Critical-emancipatory action research

In Critical-emancipatory action research, classroom problems are viewed as moral concerns rather than as purely technical. This type of action research is based on the interpretations of classroom practitioners. It gives priority to reflect on classroom practices that thwart accomplishment of classroom goals. It also deviates from more conventional action research in terms of its field work methodology. A significant action research work of critical emancipatory type has been developed in Deakin University.

Deakin Model

Action research process is a series of reflective spirals consisting of a general plan, action, observation of action and reflection on action and then a new and revised plan with action, observation and further reflection.

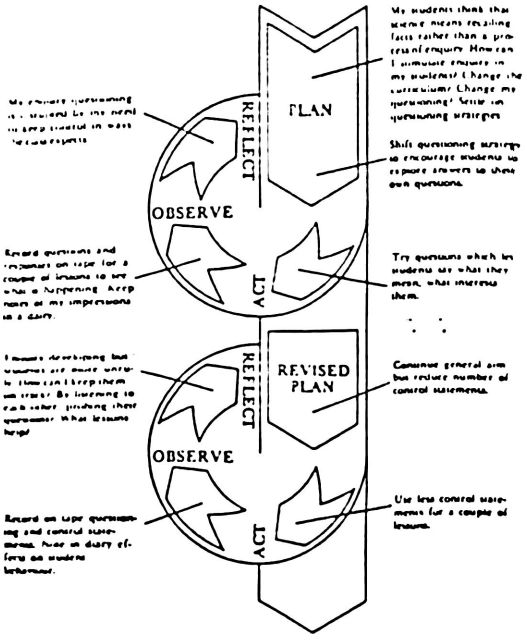


Fig. 4: Deakin action research model
(Source: McTaggart et al., 1982)

There are basically four moments in this type of action research, namely, plan, act, observe and reflect. These four pertains to discourse and practice, and constructive and reconstructive.

	Reconstuctive	Constructive
Discourse (among participants)	4. Reflect retrospective on observation (reconnaissance and evaluation)	1. Plan prospective to action (constructed action)
Practice (in the social context)	3. Observe prospective for reflection (documentation)	2. Act retrospective guidance from planning (deliberate and controlled strategic action)

Fig. 5: The moments of action research
(Source: McTaggart et al., 1982)

ACTIVITY 5
Problem:
Action plan:
Action strategies:
Reflection:
Revised plan:
Action strategies:

Time-process model/McKernan's model

In a time-process model of action research there is a scope for total curriculum planning and it is not a piece

meal reform. Action research, here, is considered as a practical, technical and critically reflective process. In this model at a particular point of time (T_1) a problem or unacceptable situation which require improvement is identified. The first cycle of action starts with defining the situation or problem more clearly. A careful statement of problem leads to a need assessment. At this stage the internal (school) and external (community) constraints that impede progress are established and ranked in order of priority. The review of the situation leads to hypotheses, which will function as strategic ideas to be tested in practice. The next stage is devoted to developing an overall plan of action followed by its implementation. Then evaluation of action steps is carried out to understand the effects of action. The results are, then, shared within the group to decide on the acceptability of the steps.

The action research then moves to second cycle. Basing on the experiences of first action cycle, a revised action plan will be commenced at a time frame (T_2). The important thing about the second action cycle (T_2) is that the original research problem is allowed to redefine itself on the result of the action taken in time period T_1. In T_2 the collaborating group may have various ideas or hypotheses for improving the situation. These are incorporated in revised action plan and tested empirically. On the basis of evaluation the action initiatives in T_2 are further

subjected to scrutiny and decisions are reached. If necessary, this would form the basis for third (T_3) action cycle.

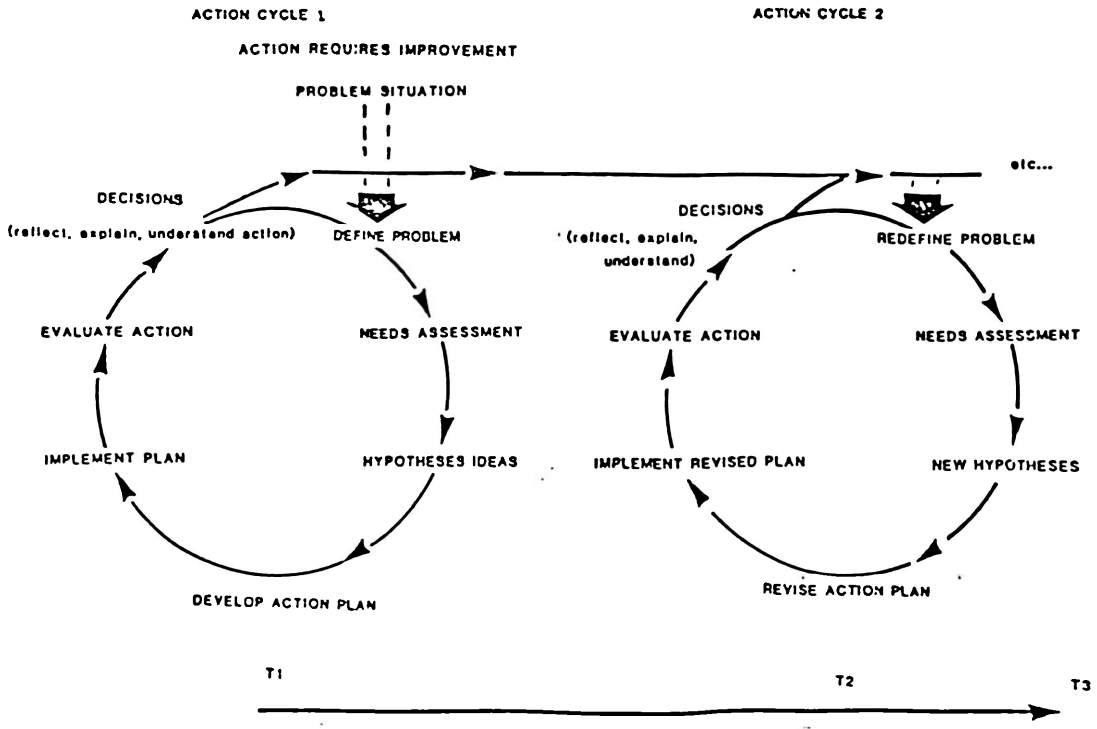


Fig. 6: McKernan's model of action research: A time process model
(Source: McKernan, 1988)

ACTIVITY 6
Action Cycle-1
Define problem:
Hypotheses:
Action plan:
Evaluation of action:
Action Cycle-2
Redefine problem:
New hypotheses:
Revised action plan:
Evaluation of action:

Overview

Keeping in view the above three types of action researches, namely, scientific, practical and critical, McKernan (1996) arrives at 16 key concepts about action research as a whole. They are -

1. Increase human understanding
2. Concern to improve quality of human action and practice.
3. Focus on problems of immediate concern to practitioners.
4. Collaborative
5. Conducted in situation
6. Participatory in nature
7. Focus on the case or single limit
8. No attempt to control setting variables.
9. The problem, aims and methodology may shift as inquiry proceeds
10. Evaluative and reflective
11. Methodologically eclectic and innovative
12. Scientific
13. Share ability and utility
14. Dialogue/discourse-based nature
15. Critical and
16. Emancipatory.

MODULE 5

EXPERIMENTAL RESEARCH

Objectives

After reading this module, you will be able to understand:

1. scientific method as basis for experimental research
2. the concept of experimental research
3. the context of experiment research in education
4. the characteristics of experimental research
5. the steps in experimental research
6. the limitations of experimental research
7. the school condition that help teachers for experiment
8. helping the teacher in each aspect of research process.

In the history of human civilisation, man was encountered with many perplexing problems in making life more comfortable and resolved such problems through a kind of systematic inquiry into phenomena. This tendency of systematic inquiry resulted in rapid advancement in science and technology, wherein the barriers of time and space were conquered. The method that facilitated the scientists for thier remarkable achivements is the scientific method. It is necessary to understand the concept of scientific method as it is the base for any experimental research.

Scientific Method

Scientific method is a systematic approach to verify ones assumptions emerged out of observation of a phenomena. The essential components in the process of scientific method are:

1. Observation
2. Formulation of hypotheses
3. Deduction of consequences and
4. Verification and proof

Observation

This is the first step in scientific method. There are two types of observations, namely,common and scientific. In scientific observation several doubts and assumptions are formulated, whereas in common observation such doubts would not arise. Though same phenomena is observed by two individuals, for one it may be common but for the other it may be scientific. For example, observing an apple falling from a tree is a scientific observation for Newton but for others it is a common observation.

ACTIVITY 1	
Give such examples:	
Common observations	Scientific observations
1.	1.
2.	2.
3.	3.

From this it is evident that scientific observation alone can help a researcher to proceed to the second step of scientific method.

Formulation of hypotheses

Scientific observation produces certain doubts. Basing on these doubts one would arrive at some assumptions. These assumptions are called as hypotheses. So all hypotheses are assumptions but not vice versa. In Newton's observation, the doubts emerged out are - Why had the apple fallen down ? Why had it not gone up ? These doubts results in formulation of a hypothesis that earth must have some magnetic attraction.

Deduction of consequences

In the third step, the consequences are deduced. If the hypothesis is true, what would be the consequences. In the present example, if the hypothesis of Newton is true, then all the objects should have to be subjected to earth's magnetic attraction and fall down.

Verification and proof

After deduction of consequences, in the final step of scientific method, one has to verify whether these consequences are really present. Truth or falsity of hypothesis is verified in this step on the basis of presence or absence of consequences respectively. In the current example, it is verified and proved that all objects fall on to earth and hypothesis is considered to be true.

Keeping this process of scientific method in mind, let us, now, peep-in into the context where experimental research is necessary in education.

Experimental Research

Experiments in education may be carried out in both action research and fundamental research. Action research experiments are generally preferred for classroom problems and experiments in fundamental research are preferred for theoretical problems.

In day-to-day classroom teaching, teachers may face several problems in bringing out desired changes among learners. In such situations they think about the problem and about possible solutions. They face difficulty in giving shape to their ideas in terms of well defined problem. Even if they define the problem correctly, they may not be able to decide the strategy of research, statistical treatment of data and drawing conclusions. On this premise it may not be apt to train them in research methodology, but it is necessary to make them understand the need to systematically practice an idea and test it in a manner that can be appreciated. We cannot expect a teacher to undertake a systematic and sophisticated research to solve his classroom problems. Hence teachers are to be acquainted with the process by which they can study their problems scientifically in order to correct their actions and evaluate their decisions. Most of the teachers face problems of various types and complexity relating to their teaching and many of

them attempt to do something about these problems. They think of number of ways to overcome such problems and tries out the efficacy of their actions within normal classroom situation.

ACTIVITY 2	
List out some classroom/school problems and strategies to overcome those problems.	
Problems	**Strategies**
1.	1.
2.	2.
3.	3.

Any of such educational research may involve experimentation at least to some-extent. Hence it is necessary to acquaint classroom practitioners with the nature of experimental research.

Experimental research

It involves finding out the functional relationship among phenomena under controlled conditions. The aim of experimental research is to study the cause and effect relationships between two variables.

In the process of experimental research, an experimentor manipulates or introduces some changes in one variable and observes the consequent effort on the other variable. Here the variable that is manipulated by the experimentor is called as "independent variable" and the other variable changes takes as a result of manipulation is

called as "dependent variable". The variables other than independent variable that may influence changes in dependent variable are called as "extraneous variables".

Hence the process of experimental research involves -

1. manipulation of independent variable,
2. control of intervening variables, and
3. observing the changes in dependent variable as a result of manipulation of independent variable.

Example: An experimentor can study the effect of a method of teaching on achievement in Mathematics. Here the method of teaching is independent variable, achievement in Mathematics is dependent variable and variables, such as, intelligence, and interest that may possible influence achievement in Mathematics are intervening variables.

ACTIVITY 3

Select a problem of your choice and indicate the variables.

Problem:

Independent variable:

Dependent variable:

Extraneous variables:

The fact that scientific method is the basis for experimental research, can best be understood when both these processes are compared.

Aspects of scientific method	Aspects of experimental research
1. Observation: Scientific observation gives raise to some doubts	1. A question for which the experimenter seeks an answer
2. Formulation of hypothesis	2. Hypothesis that describe nature of relationship between two variables
3. Deduction of consequences	3. Measurement and implementing experiment
4. Verification and proof	4. Data analysis to verify whether there is any relationship between the variables

Characteristics of experimental research

The essential characteristics of experimental research are:

* Control
* Manipulation
* Observation

I. Control

Researcher has to control all relevant variables except the independent variable. In experimental research control plays a very important role. It is not possible to infer the effects of independent variable without control. In order to understand the concept of control in experimentation, it is necessary to know about two basic laws, on which the experimental research is based.

Law of the single variable

This law states that if two situations are equal in all respect except for an independent variable, any change between two situations can be attributed to the independent variable.

Law of the only significant variable

This law states that if significant variables are made equal in two situations, any change between the two situations after manipulation of independent variable to one of the situation can be attributed to the independent variable.

The conditions of the law of single variable can be attained in basic science than in education. It is difficult to reduce educational problems to single variable, as educational research is concerned with human beings and there are always many variables present. The law of the single significant variable can be applied to educational researches. For example, in a study of effect of a method of teaching on science achievement, an experimenter is required to have two identical groups of children. As it is difficult to have two identical groups, the experimenter tries to make two groups as similar as possible in respect of those variables that are related to science achievement, namely, intelligence, motivation, etc. Other variables that are not at all related to science achievement, such as, height, weight, etc. are ignored.

ACTIVITY 4

Think of a experimental research problem and list out the variables to be controlled and ignored.

Variables to be controlled:

Variables to be ignored:

The detailed procedures of controlling extraneous variables is presented in other module.

II. Manipulation

In the process of manipulation, a predetermined set of varied conditions are imposed on the subjects selected for the experiment. The set of varied conditions is referred to as independent variable, the experimental variable or the treatment variable.

III. Observation

The experimenter is supposed to observe the changes that take place in a dependent variable as a result of manipulation of an independent variable.

Steps in Experimental Research

The steps in experimental research are similar to that of scientific method. The important steps in experimental research are -

* selection of the problem
* stating the hypotheses and

* preparing the experimental plan
* execution of the experimental plan
* data analysis

Selection of the Problem

The first step of experimental research is selection of problem. In order to select the problem, it is necessary to look at various sources. The sources and other details of selecting a problem are provided in some other module. After selection of the problem, it is to be defined. The variables to be studied should be defined in operational terms.

For example, in a problem that intends to study the effect of source materials on the achievement in history, the variables, namely, source materials and achievement in history, are to be defined operationally. The experimenter has to explain what exactly the meaning of these terms in his experiment. Here, some materials are epigraphs, archaeological findings and minuts of various rulers and achievement test score, achievement in history.

ACTIVITY 5

Select a problem of your choice and operationally define the variables.

Problem:

Definition of variables:

1.

2.

3.

Stating hypothesis

The second step of experimental research is stating the hypothesis in terms of the causal link between two variables under study. In the present example, the hypothesis can be stated as, "use of source material like, epigraphs, archaeological findings and minutes of various rulers will improve the achievement in history among X class students".

ACTIVITY 6

State hypothesis in a problem of your choice.

Problem:

Hypotheses:

1.

2.

3.

Preparing the experimental plan

The third step of experimental research is to plan the procedure of experimentation. Following points are to be kept in mind while planning the experiment.

* identify non-experimental variables and decide the procedure of control
* select a suitable experimental design
* select the procedures of collecting data
* prepare the procedure of experimental treatment

* prepare time schedule
* decide the statistical procedures

In the present example, intelligence and interest may be non-experimental variables and one group pre-test post-test design may help to contol inter-subject differences.

ACTIVITY 7

Prepare an experimental plan for problem of your choice.

Problem:

Experimental plan:

Execution of experimental plan

After preparing the plan, it is to be meticulously executed. In this fourth step of experimental research, an experimenter is expected to introduce his experimental treatment while administering the tools as per the experimental plan and collect necessary data to test the hypothesis.

Data analysis

The final step of experimental research is data analysis. The data obtained should be subjected to statistical treatment using the statistical techniques decided in the experimental plan.

ACTIVITY 8

Write suitable statistical techniques to test the hypothesis of your choice.

Hypothesis:

Statistical techniques:

1.

2.

3.

Limitations in experimental research

While conducting experimental research, teachers should keep in view the following precautions.

* The experiment should be based on needs and problems of education.
* The results of an experiment conducted on a group under certain conditions cannot be applied to other groups unless the experimental group is representative of a large population.
* The results should not be over generalised.
* The results should be interpreted with utmost caution because it difficult to control so many variables.
* The teacher should not reflect his personal bias for a particular method or factor during experimentation.

* The experiment should be conducted under normal conditions of schools.

Helping teachers to experiment

The general atmosphere of the school is very important to motivate teachers to undertake research. Teachers also require help in each aspect of research process.

School conditions

The general condition of school that help a teacher to conduct experimentation are:

* encouragement to be self-critical
* freedom to experiment
* providing for staff cooperation
* staff meetings and
* provision of time and material facilities.

Teachers are allowed to express their views on their success and also failures. This kind of self-examination and self criticism would help teachers to undertake classroom researches. Freedom should be given to teachers for conducting experiments to solve their classroom problems. For conducting experiments, cooperation from other teachers is necessary. All teachers are encouraged to experiment together collectively and cooperatively. During staff meetings, the progress of experimental projects may be reviewed and necessary feed back is provided to classroom researchers. Time and material, that is needed to a teacher who conducts experiment, should be provided.

Helping in each aspect of the research process

Besides school conditions, it is necessary to help teachers in each aspect of the research process. Teachers are helped to -

* become constructively dissatisfied with their own teaching
* develop hope that his problem can be solved.
* define the classroom problem.
* diagnose the difficulty.
* search for promising solutions.
* hypothesise
* plan their experiment
* execute the experiment
* analyse data
* write report

MODULE 6

EXPERIMENTAL DESIGNS

Objectives

After reading this module, you would be able to understand

1) criteria in selecting experimental designs
2) validity of research designs
3) pre-experimental designs
4) time experimental designs
5) quasi experimental designs
6) factoral designs

Experimental design is a blue print within which the experiment is conducted. The major functions of experimental design are to establish conditions for comparisons and helps the experimenter to make meaningful interpretation of the results. In order to accomplish these functions, an experimenter should keep in mind the following criteria in selecting an experimental design.

Appropriateness

The first criteria in selecting an experimental design is that it should be appropriate for testing the hypotheses of the study. The efficacy of any experimental design rests not on the complexity or simplicity but on appropriateness. Any design that facilitates an experimenter

to solve his problem on hand is considered to be a right design. Hence the important task of an experimenter is to select a design which is suitable to meet the needs of the particular problem.

For example, an interaction hypothesis can be tested with the help of factoral design. If a researcher wants to know the effects of programmed instruction and individualised instruction on achievement in science believing that there may be a differential effect of these methods on intelligence levels of students, then the factoral design is best suited design.

Adequacy of Control

The second criterion is that the design must provide adequate control so that the effects of independent variable can be measured. In order to establish relationship between the variables under study, an experimental design should control the extraneous variables. Randamisation is considered to be the best way to control extraneous variables. Hence, a researcher, as far as possible is adviced to select a design which utilises randamisation.

Validity of Research Design

The validity of a research design may be assessed through internal and external validity.

Internal Validity

However for the experimental treatment really contribute to a change in dependent variable ? is a basic question concerned with internal validity. This can be

answered only by providing adequate control of extraneous variables. Extraneous variables that normally interfere in an experimental are - History, maturation, pre-testing, measuring instruments, statistical regression, differential selection of subjects, experimental mortality and selection maturation interaction. The ways of controlling these extraneous variables are dealt in a separate module.

ACTIVITY 1

Problem:

List out extreneous variables:

1.

2.

3.

External Validity

To what population the experimental findings be generalised ? is a question concerned with external validity. There are two types of external validity, namely, population validity and ecological validity. Population validity is concerned with the identification of population to which the results of experiment can be generalised. Ecological validity is concerned with generalising experimental effects to other environmental conditions.

ACTIVITY 2

Problem:

Population Validity:

Ecological Validity:

In experimental research, one variable is manipulated and the effect of this manipulation on a second variable is observed. The variable which is manipulated is known as the independent variable or experimental variable and the variable on which the effect of the manipulation of independent variable is observed, is known as dependent variable. Experimental design helps a researcher to test the hypothesis. There are four important types of experimental designs. Any one of these experimental designs can be selected by a researcher, depending on the nature of his problem under investigation.

I. Pre-experimental designs

II. True experimental designs

III. Quasi-experimental designs and

IV. Factoral designs

I. Pre-experimental designs

In these designs, the extraneous variables are sometime little controlled or sometimes not controlled. There are two such designs listed under this type.

One group pre-test post-test design

In this design the experimenter conducts pre-test and post-test to measure the dependent variable before and after the exposition of independent variable respectively. Any difference in pre-test and post-test may be attributed to the independent variable.

Pre-test	Independent variable	Post-test
T_1	X	T_2

ACTIVITY 3

Problems:

Independent variable:

Dependent variable:

Pretest :

Posttest:

The major limitations of this design are - (1) As there is no control group, pre-test and post-test difference may not be definitely attributed to experimental treatment, and (2) The two important extraneous variables, namely, history and maturation, are not controlled in this design.

Two group static design

In this design two groups are used and experimental treatment is provided to one group. The other group to which the independent variable is not exposed, acts as control group. There is no pre-test in this design. Experimenter assumes that the both the groups are equivalent. Post-test scores on dependent variable (Y) are compared to determine the effect of independent variable (X).

Groups	Independent variable	Post-test
Experimental	X	T_2
Control	No X	T_2

ACTIVITY 4

Problem:

Experimental treatment:

Indpendent variable:

Dependent variable:

Posttest:

The major limitation of this design is that it lacks proper control of extravenous variables.

II. True Experimental Designs

These designs are mostly used in educational research. In these designs, experimenter attempts to control the extranenous variables. There are four types of designs in true experimental designs.

Two groups, Randomised subjects, Post-test design

In this design in order to control extraneous variables, subjects are assigned to two groups through randomisation. There is no pre-test and only post-test is administered to measure the dependent variable after exposing independent variable to experimental group. Control group is not exposed to independent variable.

Groups	Independent variable	Post-test
Experimental	X	T_2
Control	No X	T_2

ACTIVITY 5
Problem:
Ramdamisation:
Independent variable:
Dependent variable:
Posttest:

The advantages of this design are - (1) equivalence of groups may be attained through randomisation, (2) Controls main effects of history and maturation, as there is no pre-test and (3) This is useful specially for primary stage.

The limitation of this design are - (1) external validity of the experiment is restricted and (2) It may not be possible always to select subjects at random.

Two groups, Randomised Matched Subjects, Post-test Design

In this design subjects are assigned through randomisation to both experimental and control groups by using the technique of matching. Experimental treatment is given to the experimental group. After experimental treatment post-test on dependent variable is given to both the groups.

Groups	Independent variable	Post-test
Experimental	X	T_2
Control	No X	T_2

ACTIVITY 6

Problem:

Matching the subjects:

Independent variable:

Dependent variable:

Posttest:

The advantage of this design is that it attempts to control pre-existing inter-subject differences. The major limitation in this design is that it may not be, always, possible to locate a match of one or more potential subjects.

Randomised groups, Pre-test, Post-test design

In this design, subjects are assigned to both experimental and control groups by using random procedures. A pre-test (T_1) is administered to measure dependent variable Y. The independent variable (X) is exposed to experimental group. After experiment, both groups are administered the post-test (T_2).

Groups	Pre-test	Independent variable	Post-test
Experimental	T_1	X	T_2
Control	T_1	No X	T_2

ACTIVITY 7

Problem:

Randamisation:

Independent variable:

Dependent variable:

Pretest:

Posttest:

The advantages of this design are - (1) random assignment of subjects to ensure equivalence between groups prior to experiment, (2) control over pre-test provides an additional check on the equality of groups and (3) randomisation helps to control most of the extraneous variables.

The limitations of this design are - (1) the interaction between pre-test and experimental treatment, (2) interaction of selection of subjects and experimental treatment and (3) the interaction of experimental variable with other factors.

Randomised Solomon three groups design

In this design there will be three groups. Subjects are assigned to groups through randomisation. This design

uses a second control group in addition to experimental and control groups. The second control group is not pre-tested but exposed to independent variable. After the experimentation all the three groups are administered a post-test.

Groups	Pre-test	Independent variable	Post-test
Experimental Group (E)	T_1E	X	T_2E
Control Group-1 (C_1)	T_1C_1	No X	T_2C_1
Control Group-2 (C_2)	No T_1	X	T_2C_2

ACTIVITY 8

Problem:

Randamisation:

Independent variable:

Dependent variable:

Pretest:

Posttest:

The advantages of this design are - (1) limited randomisation assures equivalence between groups prior to experimentation and (2) second control group control the interactive effect of pre-test and experimental treatment.

The major limitation of this design is that it does not control the effects that may occur between pre-test and post-test.

Randomised Solomon Four Group Design

In this design the subjects are assigned at random to the four groups. Experimental group and one of the control groups are administered pre-test. The other two control groups are not pre-tested. Experimental treatment is given to experimental group and one of the control groups. For two of the control groups, the experimental treatment is not given.

Groups	Pre-test	Independent variable	Post-test
Experimental Group (E)	T_1E	X	T_2E
Control Group-1 (C_1)	T_1C_1	No X	T_2C_1
Control Group-2 (C_2)	No T_1	X	T_2C_2
Control Group-3 (C_3)	No T_1	No X	T_2C_3

ACTIVITY 9

Problem:

Randamisation:

Independent variable:

Dependent variable:

Pretest:

Posttest:

The advantages of this design are - (1) It provides control over any possible effects that may occur between pre- and post-tests and (2) Experiment is conducted twice.

The limitations are - (1) it is difficulty to carry out in practical situations and (2) it is difficult to carry out statistical treatment. This design is generally recommended for advanced level of research.

III. Quasi-Experimental Designs

These designs provide as much control as possible under existing conditions.

Non-randomised control group, pre-test post-test design

Normally in school situations it may not be possible to randomise the groups which may result in dislocation of school schedule. In such situations, experimenter may use pre-assembled groups and administer a pre-test to both the groups. Pre-test scores are analysed to show that there is no significant difference between the groups. Then random procedure may be used to decide experimental and control group. Experimental treatment is provided to experimental group and then post-test is administered to both the groups.

Groups	Pre-test	Independent variable	Post-test
Experimental	T_1	X	T_2
Control	T_1	No X	T_2

ACTIVITY 10

Problem:

Independent variable:

Dependent variable:

Pretest:

Posttest:

The advantages of this design are - (1) the reactive effects are controlled and (2) it can be conducted in normal school situations. The major limitation in this design is the effect of extraneous variables.

Rotation Group Design

This is also known as counter balanced design. In this design each group is exposed to the all experimental treatments through replication. The order of this exposure differs for each group but the sequence is usually the same.

Replication	Method A	Method B
Unit 1	Group 1	Group 2
Unit 2	Group 2	Group 1

ACTIVITY 11

Problem:

Replication procedure:

Independent variable:

Dependent variable:

Measurement:

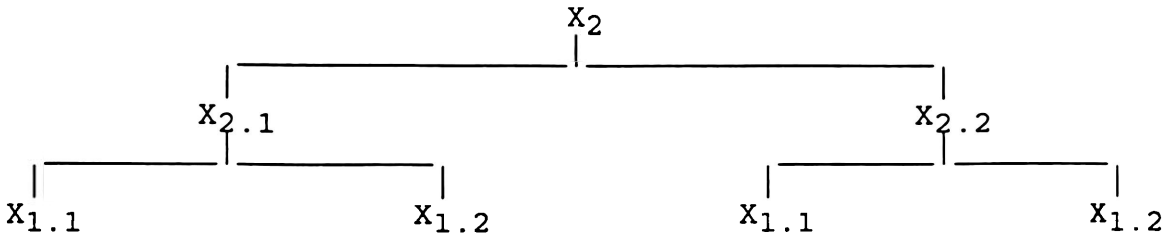
The main advantage of this design is that it eliminates the effect of those variables which cannot be controlled. The major limitation of this design is that it can be used only when the experimental treatments are such that exposure to one treatment which may not effect on subsequent treatment.

IV. Factorial Designs

In these designs, an experimenter would manipulate several variables simultaneously in order to assess the effect of each variable and the effects due to interaction among the manipulated variables. This design is complex and may not be suitable to a school teacher.

Simple Factorial Design of 2 by 2

In this design there are two independent variables and each of them have two values. The first independent variable, which is manipulated and has two values, is called experimental variable. The second independent variable, which is divided into levels, may be called as the control variable.



At the end of experimentation the groups are administered a post-test. The results are analysed to know the main and interactive effects by computing means.

X_2	X_1	
	$X_{1.1}$	$X_{1.2}$
$X_{2.1}$	$\bar{X}_1$	$\bar{X}_2$
$X_{2.2}$	$\bar{X}_3$	$\bar{X}_4$
Main	$\bar{X}_{M_1}$	$\bar{X}_{M_2}$

Main effects can be assessed by comparing $\bar{X}_{M_1}$ and $\bar{X}_{M_2}$ where $\bar{X}_{M_1}$ is mean of $\bar{X}_1$ and $\bar{X}_3$ and $\bar{X}_{M_2}$ is mean of $\bar{X}_2$ and $\bar{X}_4$. If $\bar{X}_{M_1}$ is greater than $\bar{X}_{M_2}$, then it may be inferred that $X_{1.1}$ is effective than $X_{1.2}$.

Interaction effect is assessed by drawing a graph between X_2 levels and means of dependent variable ($\bar{X}$).

If there is interaction, the effect of X_1 on dependent variable will differ for the two levels of X_2. In such situation, the lines shown in above figure intersect. If there is no interaction, the lines, more or less, will be parallel.

ACTIVITY 12

Problem:

Independent variable:

Dependent variable:

Measurement:

The main advantages of this design are - (1) The differences in the effect of different levels of more than one variable can be studied simultaneously and (2) it provides an opportunity to study interactions between the factors. The limitation of this design is that the statistical analysis of the data becomes difficult.

Overview

All the designs discussed here, have certain advantages and limitations. Each is useful in different situations and for different types of problems. None of them is useful for solving all types of problems. Thus the appropriateness of an experimental design depends upon the nature of the problem. While selecting a design, the researcher should take into consideration the advantages and limitations of each design to the specific problem.

MODULE 7

EXPERIMENTAL CONTROL

Objectives

After reading this module you would be able to understand,

1. the reasons to control variables
2. methods for controlling inter-subject difference
3. methods of controlling situational variables

The researcher encounters a number of difficulties in applying the experimental designs to the educational problems. One major difficulty he faces is that of controlling all the variables, that possibly effect a change in dependent variable. The process of controlling extraneous variables is called as experimental control, which is an important ingredient of experimental research. A researcher is required to control variables for the following reasons.

1. **Achieving isolation**: This prevents all factors other than independent variable from affecting the dependent variable. The researcher may have to remove these interfering variables or keep constant their effects or equalise their presence in both experimental and control groups.

2. **Achieving changes in magnitude**: Besides isolating the independent variable, a researcher has to ascertain how much effect it contributes. For this he must be able to vary the magnitude of the independent variable.

3. Achieving quantitative evaluation: The purpose of any research is to know the magnitude of the variable in quantitative terms. When two variables are related, a research should be able to specify the degree of relationship in terms of some numerical values.

ACTIVITY 1
Problem:
Write how you would achieve
1. Isolation:
2. Changes in magnitude:
3. Quantitative evaluation:

Methods of Control

In most of the educational research, human factors are dominant. Since human nature is complex, there are many variables present while dealing with human beings in an experimental setting and it is very difficult to control these variables. Therefore in experimental research, an attempt may be made to control those variables which have direct bearing on the dependent variable. These variables may be responsible for inter-subject difference prior to experimentation. Apart from inter-subject differences, there may be some situational variables that might operate in the experimental situation itself. A classroom researcher has to control these inter-subject differences and situational variables. Methods of controlling them are detailed below.

I.Methods for controlling inter-subject difference

Some of the important methods of reducing inter-subject differences, in order to establish equivalence of groups, are:

1. Random assignment of subjects to groups.
2. Matching subjects with random assignments.
3. Random assignment on the basis of homogeneous selection.
4. Technique of analysis of co-variance, and
5. Method of using subjects as their own control.

1. Random assignment of subjects to groups

Randomisation may be considered as best method of attaining experimental equivalence. A researcher can use this method in assigning subjects into two groups. In this method, researcher has to give a serial number to all the subjects and use any random procedure to select required number of subjects for two groups. Assigning teachers, classroom, equipment, etc. also should be on random basis.

2. Matching subjects with random assignments

In this method individual subjects are matched on as many extraneous variables as possible and assign one member of each matched pair to the groups by using any random technique. These matching procedures are generally used. The researcher has to use the matching procedure feasible to his experimental context.

a. Procedure of subject-to-subject matching: In this procedure, researcher has to identify two members from

available subjects who score within the limits on a extraneous variable and randomly assign one member of the pair to one group and other member to the other group. It is a suitable procedure, if there is one extraneous variable. It is difficult to follow this procedure when there are more than are extraneous variables.

b. Matching for mean and standard deviation: In this procedure the groups are matched on the basis of relevant variables rather than individuals. For this the researcher has to establish that the two groups do not differ significantly in terms of mean and standard deviation of the extraneous variables. Then he randomly assigns the groups to two experimental conditions.

c.Ranking of subjects on the matching variable: In this procedure all the subjects are arranged in a rank order on the basis of their scores on the extraneous variables. Irrespective of difference, the first two subjects are selected and then they are randomly assigned to two groups. Similarly next pair of subjects in the rank order are assigned to two groups.

3. Random assignment on the basis of homogeneous selection

In this method, researcher has to select groups that are homogeneous on extraneous variable. After selecting the subjects from the homogeneous population, the researcher can randomly assign subjects to two groups.

4. Technique of analysis of co-variance

This is used to control the variation within the groups. This technique analyses the difference between the two groups on the dependent variable after taking into account any initial difference between the groups or pre-test measures.

5. Method of using subjects as their own controls

In this method of experimental control same subjects are assigned to two experimental treatments. Then, the researcher would get measurements of the subjects first under one treatment and then under the other.

ACTIVITY 2
Problem:
Variables:
Write how you would control inter-subject difference.

II. Methods of controlling situational variables

There are three important methods of controlling situational variables.

1. Method of holding situational variables constant

In this method, the researcher has to be treat all the subjects alike except for their exposure to the independent variable.

2. Method of randomisation

In this method, the researcher has to randomly assign the teachers, apparatus, etc. to both the groups.

3. Method of manipulating situational variables

The situational variables can be controlled by manipulating them systematically. The researcher can use a sequence of experimental and control conditions in order to control programs effects. This can be done by controlling the order in which experimental conditions are presented through a counter-balance, half the subjects may be given AB order and the other half BA order.

ACTIVITY 3
Problem:
Variables:
Write how you would control situational variables.

MODULE 8

SELECTION OF CLASSROOM PROBLEMS

Objectives

After reading the module, you would be able to

1. identify important sources for problem selection.
2. evaluates a research problem.
3. locate classroom problems.

Any educational research starts with indentification of a problem. Selection of suitable problem for investigation is a very important task in educational research. In this process of identification of research problem, a researcher should first choose a broad area within which he proposes to undertake research.

Sources of research problem

The broad area that has been selected for a study, should be narrowed down to a specific research problem. In order to specify the research problem, there are several sources, wherein, a researcher can select his research problem. They are experience, theory and literature.

Experience

The professional experience of the researcher is a very important source of research problem. As a result of his own classroom interactions, a research would get some new insights into the different ways of effective

performance of a given task. As a result of this, he would take some decisions about his transaction modes. The effectiveness of these transactional modes can be scientifically investigated. For example, a teacher may want to evaluate the efficacy of problem solving method over conventional method in improving learner's achievement in Mathematics.

Theory

Educational and behavioural theories are other excellent source of research problems. There are many theories, whose applicability may be investigated in educational and classroom contexts.

Literature

Related literature is another important source of research problems. Research reports, research articles, periodicals, etc. suggest areas that need research. After reviewing selected researches and literature, a research would be able to smell certain gaps and undertake a research study to answer certain research questions.

ACTIVITY 1

List out problems from these sources.

Experience:

Theory :

Literature:

Evaluating the Research Problem

A research problem has to be evaluted after selection. In order to evaluate the problem, a researcher should see how far the following characteristics are applicable to it.

1.Contribution to the body of knowledge in education

The problem should be able to fill in gaps in present knowledge or resolve in consistencies in previous research.

2. Scope for further research

A research problem, besides, answering several questions, should generate number of other questions that need further research.

3. Researchability

A problem can be researchable only when it is concerned with the relationship between two or more variables that can be defined and measured.

4. Novelty

A researcher should select a problem which has not been, so far, investigated.

5. Suitability to particular researcher

A problem, however good, should be suitable to the abilities of a researcher.

* The problem should be in an area in which the researcher is competent.
* The problem should be in an area in which the researcher is interested.
* The problem should be within the financial resources of the researcher.

* The problem should be studied within the time available to researcher.

ACTIVITY 2
Select a problem and evaluate it in terms of
Contribution
Scope for further research
Researchability
Novelty
Suitability

Locating Classroom Problems

Classroom teaching is not monotonous but a creative activity to initiate desired educational outcomes. Creative and enthusiastic teachers apply their minds, judgements and imagination to make classroom process more meaningful and palatable to the learners. Classroom problems emerges out of process of reflection by the teacher, wherein, he is supposed to take some decisions to resolve them. If teachers identify a gap between their intentions, aspirations, teaching aim and the knowledge or skills or attitudes actually demonstrated by the pupils, then that creates the classroom problem. Some of the problems are quite readily dealt with. Most of the teachers may, out of their experience, know how to tackle the problem. They might be knowing about several intervention strategies that are successful in the past. At this juncture, teachers have to

select a strategy and procedure that is most appropriate in the situation out of which the problem arises. This is where the action research process starts, with the decision that something new and better must be worked out and tried in a classroom situation. Problems that teachers encounter in their teaching can be classified under four areas. They are-

1. Teaching aims,
2. Motivating learners,
3. Learning activities, and
4. Evaluation of learning outcome.

Teaching aim

The basic questions that could arise in deciding the aims of teaching are - What kind of changes am I trying to bring about in my students ? In what way should my students be different after my teaching ? and finally, what should be my teaching aim ? In the process of answering these questions teachers would be able to identify some specific problems pertaining to specific classroom context and decide the cause of action in their teaching.

Motivating learners

Another important question that a teacher should try to answer and decide what to do, is 'What can I do to make my students attentive in my class ? What incentives can I use to accelerate learning ? How to create interest among my student in the subject I teach ? While answering these questions, teachers would solve many motivational issues and make classroom teaching more effective.

Learning Activities

Learning activity is anything that a teacher ask their students to do in order to make their learning more effective. In this third area, teachers would try to find out answers to questions, such as, 'What can I ask my students to do that will enable best learning ?'

Evaluation of learning outcomes

The effectiveness of any classroom teaching would best be understood only through evaluation of progress made by learners. Most of the teachers face problems in deciding the evaluation procedures. So every teacher tries to seek answer to question, "What techniques and procedures can I use to find out the learning outcomes ?"

ACTIVITY 3
Write research problems under these areas:
1. Teaching aim:
2. Motivating learners:
3. Learning activities:
4. Evaluation of learning outcome:

MODULE 9

HYPOTHESIS

Objectives

After reading this module, you would understand

1. the meaning of hypothesis
2. the importance of hypothesis
3. sources of hypothesis
4. characteristics of hypothesis
5. different forms of hypothesis
6. difficulties in the formulation of hypothesis.

Hypothesis is defined as the tentative conclusion for the solution of a problem. It is only a statement that may or may not be true.

I. THE MEANING OF HYPOTHESIS

A hypothesis is a statement temporarily accepted as true in the light of what is at the time, known about a phenomenon, and it is employed as a basis for action in the search for new truth.

A hypothesis is a tentative assumption drawn from knowledge and theory which is used as a guide in the investigation of other facts and theories that are yet unknown.

It is a guess, supposition or tentative inference as to the existence of some fact, condition or relationship relative to some fact, condition or relationship relative to some phenomenon which serves to explain such facts as already are known to exist in a given area of research and to guide the search for new truth.

II. IMPORTANCE OF HYPOTHESIS

The importance of hypothesis can be more specifically stated as under:

1. It provides direction to research. It defines what is relevant and what is irrelevant.
2. It sensitises the investigator to certain aspects of the situation which are relevant from the stand point of the problem at hand. It spells the difference between precision and haphazardness, between fruitful and fruitless research.
3. It is guide to the thinking process and the process of discovery.
4. It focuses research.
5. It prevent blind research.
6. It sensitises the individual to facts and conditions that might otherwise be overlooked.
7. It place clear and specific goals before us.
8. It serves the function of linking together related acts and information and organising them into one comprehensible whole.

9. It enables the investigator to understand with greater clarity his problem and its ratifications,as well as the data which bear on it.
10. It serves as a frame work for drawing conclusions.

III. SOURCES OF HYPOTHESIS

The specific source of hypothesis are from general culture, from scientific laws or theories, personal experience and analogies.

IV. CHARACTERISTICS OF HYPOTHESIS

1. The hypothesis should be precise enough to become the solution to a specific problem.
2. It can be tested or verified either immediately or eventually.
3. Hypothesis is a clear picture of what the end product of the investigation will be.
4. It is logically consistent, free of ambiguousness.
5. The simplest hypothesis that is adequate to embrace the problem.
6. A hypothesis must posses explanatory power.
7. The hypothesis should state the expected relationship between variables.

ACTIVITY 1

Formulate some hypotheses, keeping these characteristics in mind:

1.

2.

3.

V. DIFFERENT FORMS OF HYPOTHESIS

The hypothesis can be stated in a number of forms. They are:

1. NULL FORM

It states that no significant difference exists between the variables concerned. For example: There is no significant difference in the instructional standards of single shift and double shift schools. The null form is preferred by most of the experienced research personnel. This form of statement more readily defines the mathematical model to utilised in the statistical test of the hypothesis. The no-difference statement assumes that the two groups will be tested and found to be equal.

2. PREDICTION FORM

It is chosen because it allows the research worker to state principles which he actually expects to emerge from the experiment. This type of hypothesis is more useful in action research studies.

3. DECLARATIVE FORM

It generally states a relationship between the variables concerned. For example, we can state that there will be a significant difference in the instructional standard of boys and girls schools.

4. QUESTION FORM

The above mentioned hypothesis in question form may read - Is there a significant difference in the instructional standards of boys and girls schools ?

ACTIVITY 2

Write different forms of hypothesis.

Null

Prediction

Declarative

Question

VI. DIFFICULTIES IN THE FORMULATION OF HYPOTHESIS

There are number of difficulties from which a beginner may suffer at the stage of formulating a good hypothesis.

1. Lack of knowledge and clarity of the theoretical frame work of the area in which the investigator chooses to work.
2. Lack of ability to make use the theoretical frame work logically.
3. Lack of acquaintance with available research technique resulting in failure to be able to phrase the hypothesis properly.
4. Vagueness of the statement. For example, a course in ethics will make a student a more ethical adult.

MODULE 10

TOOLS FOR DATA COLLECTION

Objectives

After reading this module, you would be able to

1. understand different types of tools for collecting data
2. develop the tools for collecting necessary data.

In any type of educational research, tools are essential to collect necessary data. Depending on the nature of problem under investigation, a researcher has to select from the available tools which would provide data he needs for testing hypotheses. If the available tools do not suit, then a researcher has to prepare one which suits his problem under investigation. For this it is necessary to acquaint with different types of tools. The major research tools are classified as follows:

1. Psychological tests
2. Inquiry forms
3. Observation
4. Interview and
5. Sociometric Techniques

1. Psychological tests

The most useful tools of educational research are psychological tests. They are designed to measure intelli-

gence, aptitudes, creativity, achievement, personality traits, interests, attitudes, etc. As these tests are objective and standardised, they are mostly used in educational research.

Development of Test

When available tests are not suitable to the problem under investigation, a researcher may have to develop a test. The procedure to be followed in developing a test is as follows.

Planning: While developing a test, a researcher should first think of the purpose, time, cost and sources. The nature of population for which the test is intended should be clearly defined. Researcher also has to plan the length of test, type of test items and method of scoring.

Preliminary draft

After planning for the test, researcher has to prepare a preliminary draft items. While preparing the draft items he has to consult the existing tests in the area. The preliminary draft must have more than double the items required for the test. Items are then edited and carefully worded. These draft items are to be given to experts for their comments.

ACTIVITY 1

Prepare some draft items to measure any psyuchological variable.

Name of the variable

Items

1.

2.

3.

4.

5.

The tryout: The preliminary draft then is to be administered to a tryout sample. The responses of subjects are to be scored according to the scoring key.

Item analysis: In order to assess how far each item, of the preliminary draft, is able to discriminate from high and low groups, item analysis is carried out. Only then test items which are able to discriminate between high and low are retained and remaining items are removed.

Final draft: Final draft consists of those items which are accepted in the item analysis. This final test would be administered to the original sample.

2. Inquiry Forms

Inquiry forms gather information about a phenomena under study. Questionnaire, schedule, checklist, rating

scale and opinionnaire or attitude scale are some of the important tools comes under this category.

Questionnaire

Questionnaire consists of questions to obtain necessary information from the respondents. It is a popular and widely used tool to collect data in educational research. It may either be administered personally or sent through mail to the respondents. In a questionnaire, questions may be in closed or open form.

Guidelines for preparing a questionnaire

1. The objectives of the study should be reflected in the questions.
2. Questionnaire should motivate the respondents to communicate required information.
3. Language used in the questionnaire should be suitable to the level of respondents.
4. Questionnaire should ask such questions for which information is available with respondent.
5. There should be no leading questions in the questionnaire
6. Questions should be arranged in a logical sequence.
7. Questionnaire should not be too lengthy.
8. Questions should be given to experts for assessing their relevance.
9. Questionnaire should be tried out on a try-out sample.
10. Validity and reliability of the questionnaire need to be established.

ACTIVITY 2

Keeping in view the guidelines of preparing a questionnaire, write some draft items to collect information of your choice.

Name of information

Closed form

1.

2.

3.

Nature of information

Open form

1.

2.

3.

Schedule

Schedule is a device consisting of a set of questions which are asked and filled by the researcher in a face-to-face situation.

Checklist

A checklist is a simple device consisting of a list of items relevant to the problem under study.The respondent/ observer would indicate the presence or absence of the item by checking 'yes' or 'no' in the space provided against each item.

Rating Scale

Rating scale consists of a set of points which describe varying degree of the dimension of an attribute being observed. There are number of rating techniques which enable the observers to ascribe numerical values or ratings to their judgements of behaviour. These techniques are - (1) numerical scales, (2) graphic scales, (3) standard scales, (4) rating by cumulative points and (5) forced choice ratings.

Numerical Scales

In these types of scales, a sequence of defined numbers is supplied to the observer. The observer assigns to each item, an appropriate number to indicate his rating.

Graphic Scales

In this scale, against each item, a line is provided, with a response continuum. The rater will provide his judgement on that item by checking one point in this continuum.

Standard Scales

In standard scales a set of standards is provided to the rater. The standards are usually objects of same kind to be rated with pre-established scale values.

Rating by cumulative points

The unique feature of this type of rating is in the method of scoring. The rating score of an individual is the sum of the weighted or unweighted points.

Forced choice ratings

In this method the rater is asked to say whether an individual has more of one trait than another of a pair.

Guidelines in preparing a rating scale

1. A clear definition of the trait to be rated should be provided.
2. Rating scale should have a relevant and suitable response continuum, to the trait that is to be rated.
3. Though, there is no strict rule on the number of scale divisions to be used, it is advisable to have 5 to 7 point scales.

ACTIVITY 3

Keeping the view the rating techniques and guidelines in preparing a rating scale, prepare a list of items.

Name of the variable

Numerical scale: 1.
2.
3.

Graphic scale : 1.
2.
3.

Standard scale : 1.
2.
3.

Rating by cumulative points : 1.
2.
3.

Forced choice ratings : 1.
2.
3.

Opinionnaire or Attitude Scale

The inquiry form that attempts to assess the attitude or belief of an individual is known as an opinionnaire or attitude scale.

3. Observation

In the process of observation, an observer observes the happenings in real life situations and record them according to a pre-planned scheme. Proper planning, implementation and recording is necessary for effective observation.

Planning

While planning for observation following factors are to be considered.

1. Definition of specific activities to be observed
2. Length of observation
3. Scope of observation
4. Recording procedures
5. Training of observers

Implementation

1. Focussing attention on the specific activities to be observed.
2. Using appropriate recording procedures.

Recording

The recording may take place either simultaneously or soon after observation observer should take precaution to

minimise the influence of his bias, attitudes and feelings on the observation report. Anectodes, time sampling method, incident sampling method and diary method may be used in recording.

The advantages of observation method are - (1) it is an effective way to gather data in a particular situation, and (2) behaviour is recorded at the time of its occurrence. The important limitations are - (1) subject may hide his behaviour when he knows that he is being observed and (2) it is time consuming.

ACTIVITY 4

Prepare a plan for observation.

Aspects to be observed:

Specific activities to be observed:

1.

2.

3.

Scope of observation:

Recording procedures:

4. Interview

The interview is a process in which researcher would collect necessary information or data from the subjects

in a face-to-face situation. Interviews are classified as 'structured' and 'unstructured'. Standardised and pre-determined procedure is followed in structured interview to collect relevant information. Unstructured interview is flexible. Though the procedure and questions to be asked are decided in advance, researcher is free to modify them depending on the situation. The advantage of interview is that, it helps to gather more information. Limitations of interview are that it is time consuming and efficacy mostly depends on the skill of interviewer.

ACTIVITY 5
Prepare a structured interview schedule.
Nature of information to be collected:
Structured interview students:
1.
2.
3.

5. Sociometric techniques

Sociometric techniques attempt to describe preferences between members of a group. Some of the important sociometric techniques are - sociogram, sociometric matrices, guess who technique, and social distance scale.

Sociogram may be used by a classroom teacher to study the interpersonal relationships of their class. A

sociometric matrix is a rectangular arrangement of numbers indicating the choices of the group members. In guess - who technique, students are asked to read a descriptive statement and asked to write down the name of student who best fits the description. Social distance scale is another technique to measure social relationship.

ACTIVITY 6

Prepare a sociogram of a group of students consisting of ten.

The advantage of these techniques is that they are easy to administer and interpret. The limitations are - information provided is limited by the nature of sociometric questions and individuals do not reveal the reasons why they preferred some members of the group.

MODULE *11*

STATISTICS FOR ACTION RESEARCH

Objectives

After reading this module you would be able to understand the procedures of

1. preparing frequency tables
2. drawing diagrams
3. computing measures of central tendency
4. computing measures of dispersion
5. computing correlation

In our daily life, on the basis of some observations we analyse the information to draw certain conclusions or inferences. Normally we collect the information in terms of numerical figures in order to analyse the information. This set of meaningful numerical figures is known as the data. The data, after collection have to be processed and analysed in accordance with the purpose laid down at the time of developing the action research plan. The term analysis refers to the computation of certain measures. Statistics has two major purposes in the field of educational research. They are, (1) to summarise or simplify the data that have been obtained, and (2) to obtain descriptions or inferences to be made from these data.

1. Preparation of Frequency Distribution Table

The statistical data arranged and classified into a number of groups in an orderly manner on the basis of

magnitudes of the values, constitute a frequency distribution. A table representing them is known as frequency table. Marks scored in a subject by 20 students are presented in the following frequency table.

Marks (Class interval)	Number of students (Frequency)
0-20	5
20-40	3
40-60	12
60-80	5

Here the intervals, 0-20, 20-40, 40-60 and 60-80 are known as class intervals. The number of students falling within each class interval is known as frequency. The procedure of preparing frequency table from a law data, is as follows.

Preparation of frequency table for the following marks of 30 students:

72	49	63	72	11	83	93
38	23	19	26	17	44	67
29	14	39	53	57	62	56
68	76	43	91	1	15	42
17	29					

Step 1: First decide the number of classes.

Here let us take five class intervals

Step 2: Calculation of range

In the given example

Maximum value = 93

Minimum value = 1

Range = 93-1 = 92

Step 3: Calculation of class width

$$\text{Class width} = \frac{\text{Range}}{\text{Number of classes}} = \frac{92}{5} = 18.4 = 19$$

Step 4: Determination of lower limits

Since the smallest value is 1, the lower limit of first class is zero. Hence, the lower limits of the other classes are 0+19 = 19, 19+19 = 38, 38+19 = 57 and 57+19 = 76 respectively.

Step 5: Determination of upper limits

The upper limit of first class is 18 (one unit lower than the lower limit of the second class). The upper limits of the other classes are 18+19 = 37, 37+19 = 56, 56+19 = 75, and 75+19 = 94 respectively.

Step 6: Indication of classes

The different classes are:

0-18

19-37

38-56

57-75

76-94

Step 7: Putting the tally marks

The tally marks corresponding to the given values are as indicated below:

Class	Tally marks
0-18	𝍸 |
19-37	𝍸
38-56	𝍸 |||
57-75	𝍸 ||
76-94	||||

Step 8: Obtaining the frequencies

The frequencies corresponding to tally marks are

Class	Tally marks	Frequency
0-18	𝍸 |	6
19-37	𝍸	5
38-56	𝍸 |||	8
57-75	𝍸 ||	7
76-94	||||	4

Step 9: Indication of final frequency table

Class	Frequency
0-18	6
19-37	5
38-56	8
57-75	7
76-94	4

ACTIVITY 1
Prepare a frequency table from following raw data:
42, 53, 56, 39, 42, 41, 66, 38, 45, 46, 31, 43, 52, 51, 51,
36, 38, 49, 48, 51, 59, 62, 54, 51, 40, 35, 32, 37, 41, 50

2. Drawing Diagrams

The data can be represented by means of various types of diagrams, in order to simplify the complexity of statistical data and to draw the conclusions. The important types of diagrams are:

a. Bar diagrams

b. Pie diagrams

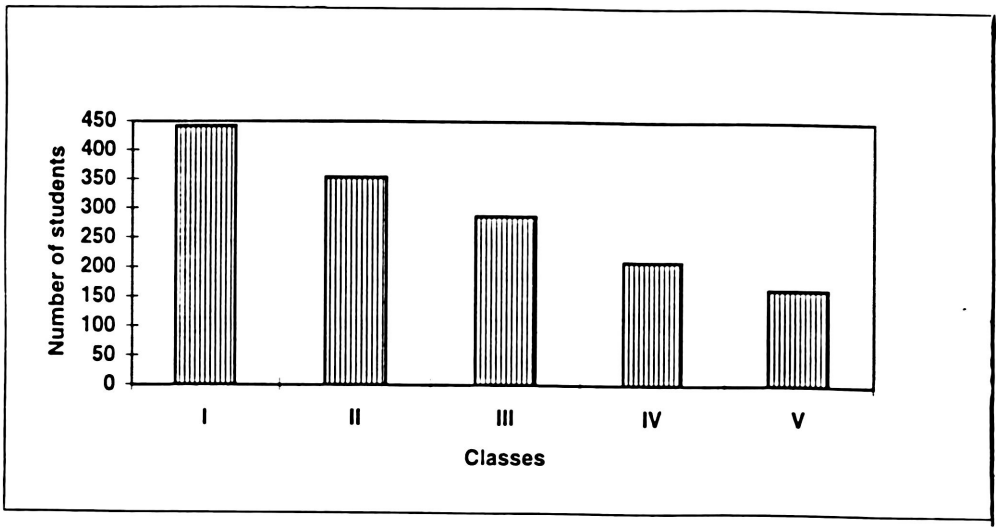
c. Histograms

a. Bar diagrams

Bar diagram consists of a series of bar with equal width. The bars stand on a common base line with equal gap between one bar and another. The bars may be either horizontal or vertical. But vertical bars are mostly prepared as they give a better look and facilitate comparison.

Preparing bar diagram for following data.

Class	Frequency
I	442
II	354
III	288
IV	210
V	163



ACTIVITY 2

Draw a bar diagram for following data

Students	Marks
A	16
B	64
C	36
D	81
E	16

b. Pie diagram

In this type of diagram, a circle is divided into different sectors so as to represent different quantities. Preparing pie diagram for following data

Language	Number of persons
Tamil	123
Telugu	146
Kannada	87
Malayalam	105
Others	24
Total	485

Step 1: Draw a circle with suitable radius (say 10 cms).

Step 2: Divide the circle into five different sectors.

The angle of the centre is 360° and it is to be divided into five parts as follows.

$$\text{Tamil} \quad \frac{123}{485} \times 360 = 91.3$$

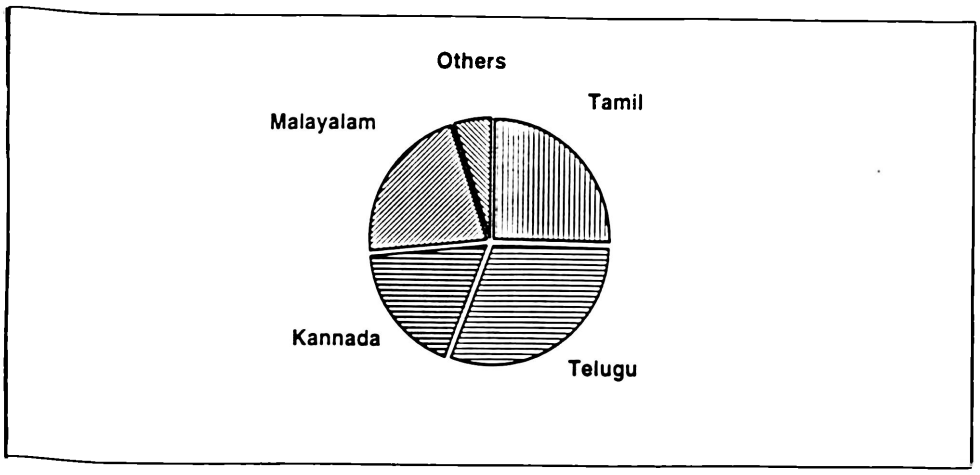
$$\text{Telugu} \quad \frac{146}{485} \times 360 = 108.4$$

$$\text{Kannada} \quad \frac{87}{485} \times 360 = 64.6$$

$$\text{Malayalam} \quad \frac{105}{485} \times 360 = 77.9$$

$$\text{Others} \quad \frac{24}{485} \times 360 = 17.8$$

Therefore, five different sectors making angles 91.3, 108.4, 64.6, 77.9 and 17.8 at the centre will be used to represent the different language groups as shown below.



ACTIVITY 3

Draw pie diagram for following data:

Boys - 68 Girls - 52

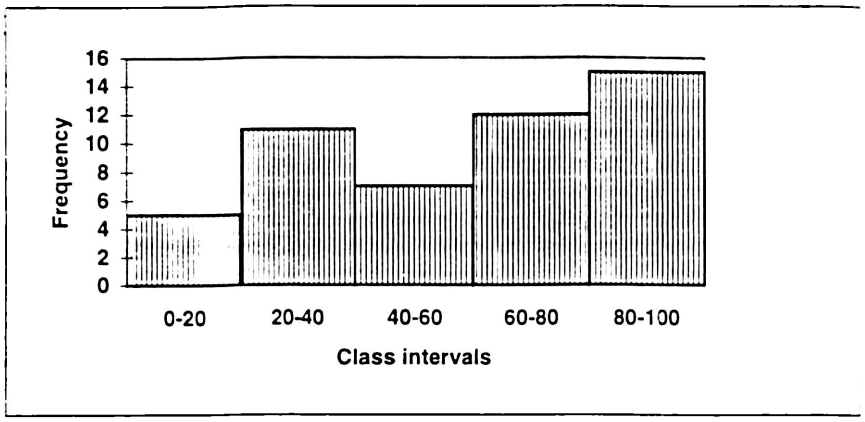
c. Histogram

In histogram, the data are represented as a series of rectangles. Class-intervals are shown on the X-axis and the frequencies on Y-axis.

Drawing a histogram for the following data:

Class intervals	Frequency
0-20	5
20-40	11
40-60	7
60-80	12
80-100	15

The histogram corresponding given data is as below:



ACTIVITY 4

Draw a histogram for following data:

Class intervals	Frequency
0-10	2
10-20	18
20-30	19
30-40	35
40-50	40

3. Computing measures of central tendency

In order to minimise the complexity of data and to make them comparable, it is essential that the various phenomena under study should be reduced to one figure each. One such figures are called 'measures of central tendency' or averages. They give the gist and concise picture of the whole data. There are three measures of central tendency,

namely, arithmetic mean, median and mode. A classroom researcher can make use of them in comparing phenomena under investigation. The procedures of computing are given below.

Arithmetic mean

The Arithmetic mean is defined as the ratio of sum of the scores and the number of scores.

$$\text{Arithmetic Mean (AM)} = \frac{\text{Sum of all sums}}{\text{Total number of scores}}$$

$$= \frac{\Sigma x}{n} \quad (x \text{ is sum of scores and } n \text{ is number of scores})$$

Example: Calculate arithmetic mean (AM) of the following data:

20, 27, 49, 56, 25, 73, 82, 91, 64, 0

$$AM = \frac{20+27+49+56+25+73+82+91+64+0}{10} = \frac{487}{10}$$

$$= 48.7$$

ACTIVITY 5
Calculate arithmetic mean 42, 53, 56, 39, 42, 41, 66, 38, 45, 46

Median

Median is the value which exceeds and exceeded by the same number of observation or values. If 'n' values in an ungrouped data are arranged in ascending or descending order of magnitude, the median is the middle value $\left(\frac{n+1}{2} \text{ th value}\right)$ when 'n' is odd. If 'n' is even then the arithmetic mean of the two middle values will be taken as median.

Example: Median for following data (where 'n' is odd)

17, 11, 23, 14, 18, 22, 27, 11, 16, 29, 10 (n = 11)

First the data should be arranged in ascending order.

10, 11, 11, 14, 16, 17, 18, 22, 23, 27, 29

Median is the middle value, i.e. 17 $\left(\frac{n+1}{2}\text{ th value}\right)$

Similarly median for following data (where 'n' is even)

18, 28, 45, 72, 19, 54, 24, 26 (n = 8)

Arrange the data in ascending order

18, 19, 24, 26, 28, 45, 65, 72

$$\text{Median} = \frac{26 + 28}{2} = 27$$

Mode

Mode is the value which occurs more frequently than others. For example, in the following data mode is 18, because this value occurs more times than the other values.

12, 17, 18, 22, 18, 15, 17, 16, 27, 18

ACTIVITY 6

Find out median and mode

31, 43, 36, 62, 51, 59, 52, 51, 58

4. Measures of dispersion

When we compare two similar types of data, the measure of central tendency may be the same in both cases, but still we find some differences in them. For example, one set of observation is 3, 5, 7, 11 and 14; the other act is 8, 8, 8, 8 and 8. For these sets, the arithmetic means are the same

but there is a difference in their nature. In the first set, the observations are varying from one another and in the second set all the observations are same. This type of difference is known as the 'dispersion' or 'variation'. There are different measures of dispersion. Out of these different measures of dispersion, range and standard deviation are discussed here under, because in most of the action researches they are useful to analyse data.

Range

Range is the difference between the largest and the smallest observations or values. In the case of the following observations, range is 70 because the largest value is 89 and the smallest is 19.

21, 47, 89, 60, 71, 46, 19, 33

Standard Deviation (SD)

The standard deviation is a more sensitive measure of dispersion than range because it takes into consideration every score, rather than just extreme scores. The square root of the variance is known as standard deviation. It is also defined as the root mean square deviation about the arithmetic mean.

Formula for SD is as follows:

$$SD = \sqrt{\frac{\Sigma d^2}{N}}$$

where d = difference from mean and N = number of scores.

Example: Calculation of SD for the following scores is shown here under.

10, 8, 17, 4, 11, 8, 12

Score (x)	Deviation from Mean (d)	d^2
17	17-10 = 7	49
12	12-10 = 2	4
11	10-11 = 1	1
10	10-10 = 0	0
8	8-10 = -2	4
8	8-10 = -2	4
4	4-10 = -6	36

$\Sigma x = 70$ $\Sigma d^2 = 98$

$N = 7$

$$AM = \frac{\Sigma x}{N} = \frac{70}{7} = 10 \qquad SD = \sqrt{\frac{\Sigma d^2}{N}} = \sqrt{\frac{98}{7}} = \sqrt{14} = 3.74$$

ACTIVITY 7

Find out SD for following data

15, 6, 13, 11, 21, 9, 14, 6, 20, 18

5. Correlation

The coefficient of correlation is to be computed to know the relationship between two variables. Here there will be two variables, in which each observation will exhibit two values, one for the each of the variables under study. Let us examine the calculation of rank correlation coefficient.

The formula for this is as follows:

$$p = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

where 'd' is the difference of ranks and 'n' is number of scores.

Example: Calculation of rank correlation coefficient to the following data.

X	85	52	59	48	64	80	61	50
Y	63	70	66	60	78	57	51	46

X	R_1	Y	R_2	$R_1-R_2 = d$	d^2
85	1	63	4	1-4 = -3	9
52	6	70	2	6-2 = 4	16
59	5	66	3	5-3 = 2	4
48	8	60	5	8-5 = 3	9
64	3	78	1	3-1 = 2	4
80	2	57	6	2-6 = -4	16
61	4	51	7	4-7 = -3	9
50	7	46	8	7-8 = -1	1

$\Sigma d^2 = 68$

$$p = 1 - \frac{6\Sigma d^2}{n(n^2-1)} = 1 - \frac{6 \times 68}{8(8^2-1)}$$

$$= 1 - \frac{408}{8x63} = 1 - 0.8095$$

$$= 0.1905$$

ACTIVITY 8

Find out coeffiicent of correlation for the following data:

X	46	74	51	38	69	54	36	56	62	43
Y	59	63	63	42	51	48	42	48	59	64

MODULE *12*

COMPUTER ASSISTANCE IN DATA PROCESSING
(MS EXCEL)

Objectives

After reading this module, you would understand.

1. What is excel ?
2. Starting Ms Excel
3. Entering data
4. Sorting the data in a column
5. Calculation using basic functions
6. Excel charts

What is Excel ?

An electronic version of a paper ledger is known as a Spreadsheet. Excel is a spreadsheet program. Microsoft Excel (or MS Excel) is one of the versions of Excel programs.

System Requirements for Microsoft Excel for Windows :

- Any IBM compatible machine with an 80286 processor or higher
- A 3.5 inch floppy disk drive
- A hard disk
- A graphics display compatible with Microsoft Windows version 3.1 or later, such as EGA or VGA
- At least 4 megabytes of memory
- Microsoft Windows version 3.1 or later in standard or enhanced mode.
- A printer is optional.

Starting Microsoft Excel

- Assume the Microsoft Excel is installed in your computer in Windows 97 Environment.
- Turn on your computer and monitor and wait until the Windows 97 desktop appears.
- Windows dialog box may appear, showing a useful tip or shortcut. Read the tip and then click (using mouse) on close to clear it from the screen.
- Now click on the **Start** button at the lower – left corner of the task bar to see a menu of options.
- Move in the menu point to the programs option at the top of the list (you need not click here).
- A sub-menu will appear listing programs, groups of programs, and some Windows 97 functions. There should be a program Microsoft Excel or MS Excel.
- Click on Microsoft Excel to start the program.
- You should now be looking at Excel for Windows screen as shown below.

Excel Screen

The Excel screen displays several items to help you perform tasks efficiently. Below are the important displays of Excel screen.

- At the very top of the screen is the Main Title bar.
- On the left side of the title bar is the program control menu icon. The letter indicates that this menu controls the entire Excel program.
- Next to Control menu icon is the name of the program, followed by the name of the document.
- On the right side of the title bar are three buttons (– ▭ ×). From left to right, they are the Minimize button (reduces Excel to an icon on the Task bar), the Restore button (changes Excel into a Window) and the Close button (closes Excel).
- Below the title bar is the Menu bar.
- On the left side of the Menu bar is a Worksheet Control icon.
- Next to worksheet control menu icon you find File, Edit, View, Insert, Format, Tools, Data Window and Help buttons to perform most frequently used operations.
- Below the Menu Bar you find Tool bars – Standard, Formatting and Formula. Each button on standard and formatting tool bars offers a shortcut method of performing commonly used file and workbook operations. The formula bar is used to enter and edit cell values.
- Below the tool bars you find the worksheet, a large planning form made up of columns and rows. The Workbook is the normal document or file type in Excel. A workbook is the electronic equivalent of a notebook which is made up of several worksheets. Most of the work you do in Excel will be on a worksheet. A worksheet is a grid of rows and columns. Each cell is the intersection of a row and a column and a unique address or reference. Notice that the rows are numbered from top to bottom along the left edge of the worksheet. The first row is numbered 1, the second 2 and so on. There are 65536 rows. The columns are labeled from left to right with letters. The first column is A, the second is B and so until on IV. There are 256 columns. Each cell is identified by the corresponding column and row number. For example the first cell is identified by A1.
- At the bottom of the worksheet you find sheet Tabs, Status Bar.
- Using scroll bars you can bring worksheet into view that does not fit on the Window.
- The first cell of the worksheet will be highlighted. This is the indication of the cell where your entry goes in. Generally, you first select the cell or cells you want to work with, and then you enter data or choose a command. Selected cells appear highlighted on your screen. The active cell is the cell in which data is entered when you start typing. Only one cell is active at a time. The active cell is shown by a heavy border. To change the active cell, move the mouse pointer to the new cell and click.

Creating a New Workbook

- When you start Excel, a new workbook opens. To begin working, just start typing. If you want to create a new workbook at any time, click the New Worksheet button. You can also choose the New command from the File menu.

Entering Data into a Cell

- Open the worksheet.
- Select the cell where you want to enter the data by using mouse.
- Type the data and press ENTER .
- The selection moves down. If you press → instead of pressing ENTER the selection moves horizontally.

Cancelling an Entry

- To cancel an entry before you have pressed ENTER, press the ESC key.
- If you have already pressed ENTER, choose the Undo Entry command on the Edit menu.

Types of data that can be entered in EXCEL Worksheet

- You can enter two types of data – a constant value and a formula.
- A constant value can be numeric value, a date, time, currency, percentage, fraction or scientific notation or any text.
- A formula is a sequence of values, cell references, names, functions, or operators that produces a new value from existing values. Formulas always begin with an equal sign (=). A value that is produced as the result of a formula can change when other values in the worksheet change.

Formatting Numbers

- When you create a new worksheet, all cells are formatted with general number format – using integer format, decimal fraction format, or, if the number is longer than the width of the cell, scientific notation.
- You can change this number format.
- Click in a cell that contains a number or enter a number in a cell.
- Click **Format** and select **Cells** to display the Format Cells dialog box.
- Click on the numbers tab to present the display options.
- Select the option and click OK button.

Filling Adjacent cells and Creating Series

- You can type any number or numerical series directly into any Excel cell.
- Click in the first cell you want to use.
- Enter number you want to repeat.
- Select the range of cells you want to fill, including the number you just entered.
- Click **Edit** and select **Fill** option.
- From the dialog box choose the desired direction up, down, left or right and click OK.
- Excel copies the number you entered into the first cell into all the selected cells.

OR

- Enter the first number of the series. Notice that there is a slight protrusion in the lower right-hand corner of the cell.

- Move the mouse pointer over this 'handle' until the pointer changes to a crosshair.
- Press the left mouse button and drag the highlight across the cells you want to fill.
- Excel copies the original value into the selected range.

To create a numbered List

- Click in the first cell, the one that will be the number 1.
- Type 1 and press ENTER .
- Type 2 and press ENTER.
- Select the cells you want to contain the series, including the cells you have just numbered.
- Click **Edit** and choose **Fill Series** option to display the Series dialog box.
- Select **Column** in the Series in group.
- Select Linear in the Type group.
- Type in the Step value field.
- Type the last number in the series in the Stop value field, or leave it blank.
- Click OK to number the cells.

You could fill a series of cells with the days of the week, the months of the year, or even an irregular series.

Editing Text in a Cell

- Select the cell that contains the information you want to change.
- Press F2 or double click the cell you want to edit.
- You can use Backspace key or Delete key or Insert key to modify the contents of the cell.

Moving data from one location to another location of Excel

- Select the cell that contains the data you want to move.
- Grab any border of the cell and drag it to the new location. If you try to drop the moved text onto a cell that is occupied, Excel warns (you can choose the option)

OR

- Select the cell that contains the data you want to move.
- Click Edit and Cut.
- Move the mouse cursor to the cell where you want to place.
- Click **Edit** and **Paste.**

Finding Numbers and Text

- Click Edit and Find.
- Type the text or value you want to locate in the Find What field.
- Select whether you want Excel to search by row or column.
- Pull down the list in the Look in Field and specify where you want Excel to look for the requested data.
- Click OK to begin the Search.
- Press Esc to close the Find dialog box.

Find and Replace Data

- Click **Edit** and Replace to display Replace dialog box.
- Type the value you want to replace in the Find What field.
- Type the value you want to place over the old value in the Replace with field.
- Click **Find Next** to jump to the first occurrence of the **Find What** data.
- Click Replace to have Excel substitute the new text for the original.

What is Formula ?

- A formulas an algebraic expression. You can use literals (actual numbers entered as part of the formula), variables (letters or names that represent numbers), and cell references as part of formulas. Formula should be entered in a cell after typing equal sign (=).

Sorting the data in a column

- Select the column.
- Click **Data** and Sort options. Sort dialog box appears.
- Choose the options and click OK.

What is a Function ?

- A function is like a formula, but it is accessed through a built-in command that you enter in a spreadsheet cell. For example, if you want to add up the contents of a range of cells you could use the add operator (the plus sign) and the individual cell designators to produce the results or you could use the sum function (SUM (A3:A20).

To find the sum of the Values in a column/row

- Highlight the cells whose sums is required.
- Highlight a cell to provide space for the sum.
- Click Σ button on the standard toolbar.

Calculation using Basic Functions

- Excel contains many useful functions. You can type a function, or a formula that contains a function directly into any Excel cell, but Excel also contains a function bar to help automate the task.
- Click in the cell you want to hold the function.
- Click on the equal sign next to the Formula bar. Excel copies the equal sign into the Formula bar and the current cell and also displays the Function bar.
- Type any characters that are part of the formula outside of the function you want to use.
- Click on the down arrow next to the sum function on the Function bar to display a list of common functions.

- Choose a function from the list by clicking on it. Excel displays a range selection dialog box.
- Enter a new range. The results of your formula or function appears at the bottom of this dialog box.
- Click on OK to close the dialog box and enter the function with its arguments in the current cell.

Formatting the Worksheet

- Enter the values you want to use in the Excel sheet
- Click **File** and **Save As** to store the spreadsheet.
- Click **Format** and Autoformat to display the dialog box.
- Use the vertical scroll bar to step through the available Autoformat designs. A preview of each design is displayed if you click on the design name.
- Click on the Autoformat design you want to use and click on OK to close the Autoformat dialog box and format the sheet or selected sheet area.

Hiding Columns/Rows

- When large sized data consisting of several rows and columns are to be entered, it is difficult to keep the title of the data and data being entered in the same screen. In such cases, the data in between along with its row/column can be hidden.
- To hide a set of rows/columns, first select the area to be hidden.
- Click **Format** and Row/column.
- Click on **Hide**.
- To unhide the hidden rows/columns, follow the same steps and click on Unhide.

Formatting Gridlines

- Excel places a grid line around every cell, but you can control which cells or groups of cells have a border to provide emphasis or focus for portions of a sheet.
- To enable or disable gridlines or change gridline colours, do the following.
- Open the sheet you want to format.
- Use **Tools** and **Options** to display the Options dialog box.
- Click on the **View** tab to get the display box.
- Uncheck the **Gridlines** box at the lower left of the Windows options group to turn off Gridline display. (Click OK here if you do not want any other effects).
- To change the gridline colour, pull down the list of colours attached to the colour field of the dialog box. Click on a colour from the pop up display to select it.
- Click on OK to make the changes effective and close the dialog box.

Creating Borders

- Highlight the cells for which you want to add a border.

- Click on the down arrow beside the Borders icon on the Excel Format toolbar to display the border choices.
- Click on the border type you want to enable. Excel updates the selected sheet area and closes the border selection dialog box.

Page Setup for Printing

- Click **File** and **Page Setup** to display the dialog box.
- The first one is the **Page Tab.** Here you specify the page orientation, scaling, print quality and paper size.
- Use the **Margins** tab to specify how much space you want to allow around the outside of the paper when you print.
- Use **Header/Footer** tab to print Header and Footer.
- Excel automatically creates a header and footer for printed sheets as default.
- Excel offers several choices for header and footer, which you can select from the pull down list beneath the header or footer field.
- The **Sheet** tab of the **Page Setup** dialog box offers still more options for formatting your sheet print out. The first option on this tab lets you specify a print area. By default, Excel automatically chooses an area of your sheet to print, based on which cells contain data. You can use the first field on this tab to print a subset of the sheet. Click on the sheet icon to the right of this field, and Excel removes the entire dialog box except the Print Area field. Now you can use your mouse to select the portion of the total sheet you want to print. Excel fills in cell references. Click again on the sheet icon on the right of this field to restore the sheet tab display. You can also select the Print area by clicking the **File** and **Print Area.**

- You can establish column headings and row titles to be repeated on every page as it prints. This can work like the Print Area facility by clicking on the sheet icon to the right of the Rows to repeat at top and the columns to repeat at left fields.

- If you click on the **Over** then **Down** button, Excel prints the sheet left to right, one page deep, and then it moves the print area down one page and prints left to right again.

Printing

- Click on **File** and **Preview** to view on the screen the sheet as it will be printed.
- Click Close button.
- Click **File** and **Print** option to display Print dialog box.
- Pull down a list of Printers by clicking on the down arrow to the right of the Printer Field at the top of the dialog box.
- Click on the printer you want and the print out will appear on the screen.

- In addition two groups on this dialog box help you decide what to print, the Print Range and the Print What groups. By default, the Print Range is set for the entire active area of the current sheet. You can decide only the first page or any page or range of pages.
- You can also select a portion of the sheet before you display the Print dialog box, and then click on selection to print only that portion of the sheet.
- Click **properties** to display properties dialog box. From this you will have options to set page orientation paper source and other printer features.

- Most of us print Excel sheets directly to a printer most of the time. However, you can choose to print to a file if you wish. For this click on **Print to File** on the Print dialog box. Excel will ask for the name of the file in which to store the information after you click on OK on this dialog box. Provide a path and file name.
- After specifying al the requirements click OK to start printing.

Excel Charts

- An Excel chart is simply a picture of your data.
- You can see the basic chart types available in Excel by viewing the first screen of the Chart Wizard dialog box.
- The Chart Wizard helps you create charts by offering suggestions for data input, chart type and other chart features.
- Click on the Chart Wizard icon on the toolbar to display the standard chart type list.
- You may select any one of them by clicking its name.

Excel Chart Components

- Titles : The chart name or the name of the certain chart components.
- Legends : Labels and colours or patterns that describe the data components of a chart.
- Labels : Text that labels data values or other chart components.
- Data : The values upon which a chart is based.
- Data Table : A sheet-like table that displays actual values associated with the current chart.
- Gridlines : Lines across a chart that help you interpret precise data values.
- Trendlines : A data analysis tool that helps predict trends.

Creating a Chart

- Open Excel and enter the values.
- Use the mouse to select the data in the columns, including the column title.
- Click on the **ChartWizard** icon on the toolbar to display the opening Wizard dialog box.
- Select the name of the chart and type of the format.
- Click **next** to display the second wizard screen. This screen shows you how the basic chart will appear, and it shows the cells included in the data area of the chart.
- Click on Next to display the **Chart Options** dialog box.

- Type the Chart title in the **Chart Title** field of this dialog box.
- Enter additional titles for the X and Y axes if you wish (wherever necessary).
- Enter additional information regarding the other tabs, if necessary.
- Click Next to move to the final Wizard screen. This dialog box lets you decide whether you want to insert the chart into the current sheet or as a separate object in a sheet of its own inside the current workbook.
- You may put the chart into the current sheet and click Finish to accept the default and create the chart.
- Grab the finished chart and drag it to a vacant portion of the current sheet so that you can still work with the original data.
- You can create any chart type in the same way.

Filtering Data

- To find and display only selected records in a database of this type, do the following.
- Click in a cell.

MODULE 13

SAMPLING

OBJECTIVES

After reading this unit, the reader will be able to

i) specify suitable objectives of a proposed study

ii) decide the sources of information

iii) judge the importance of sample studies

iv) select the suitable sample technique for his/her research

v) specify the required sample size.

OVERVIEW

Since the beginning of the twentieth century, the different activities of human beings have undergone substantial changes due to rapid developments in the fields of science and technology. To satisfy the human needs, importance is given to achieve specialisation in mass production and utilisation of goods and services of a given type with a view to getting the maximum possible benefit per unit cost. For this, a careful planning is required. In any planning there is the need for various types of quantified information to be collected and analysed in an objective manner, and presented suitably so as to serve as a sound basis for taking policy decisions in different fields of human activity. To execute its various responsibilities, the Government requires a variety of informations about different aspects like education, standard of living, etc.

Such information can be obtained through carefully planned and organised surveys.

The data on needs and resources, that would be required for proper planning and execution of projects and for assessing their effectiveness, may be classified into two types: (i) survey data comprising of data already in existence which are collected and recorded by observation or enquiry and (ii) experimental data which can only be obtained through well designed and controlled statistical experiments.

OBJECTIVES AND SCOPE OF THE STUDY

The purpose for which the study is to be conducted must be clearly and precisely laid down. This will indicate the type of information which is needed and the uses to which information obtained will be put. The various uses to which the results of a survey are usually put are

a) Fact finding: The facts might relate to knowing the educational cost, etc.
b) Comparative study: It may be desired to make a comparative study of some aspects of education.
c) Evaluative Surveys: If it is intended to evaluate existing status of any aspect of education in the background of agreed criteria, it will be necessary to have evaluative study.

After the specification of the purpose of the survey, the scope of the study must also be spelt out clearly and umambiguously. The scope of the study usually

fixes the limits of the study. The nature of the information to be collected, the geographical area to be covered and the time limit for the study are to be clearly indicated.

The objectives differ with the nature of a study. Sometimes hypotheses may be formulated and tested.

Population

The aggregate of all units of a given type under consideration is called population. A population may consist of persons, objects, attributes, qualities, behaviours of people, answers to various items of a test, cities, families, opinions of the electorate and the like. A population is a well-defined group of any of these. Defining a population means fixing the limits in terms of one or more of its various aspects. These aspects may be regarding geographical area, age, sex, socio-economic status, physical attributes, psycho-social behaviours, etc. In a study, it is necessary to specify what group of units is to be covered by the study and to assemble pertinent information and materials about the population and its subgroups that will be useful in drawing and getting in touch with the sample. These steps are particularly important since the general character of the population and many of its particular characteristics will limit the opportunities available for other aspects of the design. The costs and efficiencies of different procedures vary from population to population. The actual measurements and observations, and the materials available for use in estimation and analysis, are also

affected by the specification of the population. Hence, not only it is necessary to specify precisely the population to be studied but it is also necessary to assemble and review information about the population as carefully as other preparatory material on which the survey must rest.

Data to be collected

Once the population is identified, it is necessary to specify the type of information required - whether the required data to be collected confidentially or publicly; officially or personally; in adhoc way or regular way. The amount of data required from each unit is also clearly to be specified by identification of frames.

Statistical Units

Before a survey is conducted, the units that are counted must be strictly defined. A statistical unit is a unit of measurement applied to the data in any particular problem or investigation. For example, we investigate 'accidents', 'income', 'employment', 'waves', etc. These are statistical units. Suppose an enquiry is to be conducted about the wages of workers in some industry. Wage is a common term which may mean money wage or real wage or piece wage, wage of skilled worker, wage of unskilled worker, etc. One who conducts the enquiry must state clearly the sense in which he proposes to use the term 'wage'. The two kinds of statistical units are (i) units of collection and (ii) units of analysis and interpretation. Units of collection are those in terms of which measurements are made or data

collected. These units are again of two types, i.e. (i) simple and (ii) composite. A simple unit expresses a single condition without any qualification. For example, a worker, a building, etc. A composite unit is one which is formed by adding a qualifying word to a simple unit. For example, an industrial worker. Units of analysis and interpretation are those which make comparison possible and easy. These units include (i) rates, (ii) ratios and (iii) coefficients. Specification of statistical units determines the selection of other aspects of the study.

Census Study or Sample Study

One way of obtaining the required information at regional and country level is to collect the data for each unit (person, school, school building, etc.) belonging to the population or universe, which is the aggregate of all units of a given type under consideration. This procedure of obtaining information from all the units of population is called complete enumeration study or census study.

The effort, money and time required for carrying out census study will generally be extremely large. However, if the information is required for each and every unit in the domain of the study, a census study is necessary. For various reasons, census study may be incomplete, inadequate or inaccurate. Census studies are unattainable in practice and complete accuracy in an illusory concept. Therefore, instead of obtaining data from all the units of the population, a proper method of obtaining data from some few

selected units of the population may be used to get the required results. This type of enumeration of a subgroup of the population units is termed as sample study. The process of selection of units is termed as sampling. Sometimes sample studies are more efficient for the following reasons.

i. Reduced Cost: If data are secured from only a small fraction of the aggregate, expenditure may be expected to be smaller than if a complete census is attempted.

ii. Greater Speed: For the above stated reason, the data can be collected and summarised more quickly with a sample. This is very useful when the information is urgently needed.

iii. Greater Scope: In certain type of enquiry, highly trained personnel or specialised equipment, limited in availability, must be used in obtaining the data. In such cases, census study may be impracticable. The studies which rely on sampling have more score and flexibility as to the types of information that can be obtained. However, if the information is wanted for many subdivisions or segments of the population, the complete enumeration offers best solution.

iv. Greater Accuracy: Because, personnel of higher quality can be employed and can be given intensive training, a sample study may actually produce more accurate results than the kind of census study that is feasible to take.

v. Practicability: Many populations about which inferences are to be made are quite large. For example, consider

the population of class I students in Karnataka whose number is approximately in lakhs. The education department is interested in finding out as to what proportion of children enter the school at the specified age of enrolment ? But the big size of the population makes it physically impossible to conduct a census. In such a case, selecting a representative sample may be the only way to get the information required.

vi. Accessibility: There are some populations that are so difficult to get access to all units. For example, people in prison, crashed airplanes in the deep sea, satellites in space, etc. The inaccessibility may be economic or time related. Therefore, in case of inaccessible populations, only sample study is possible.

Based on the resources, the choice of census study or sample study is to be determined. If the study is a sample study then (a) choice of sampling unit, (b) identification of sampling frames, (c) determination of the sample size and (d) selection of the sample should be specified.

Sampling Unit

A decision has to be taken concerning a sampling unit before selecting a sample. Sampling units are usually of the following:

i. Geographical units such as state, district.

ii. Social units such as family, club, school, etc.

iii. Individuals

iv. Construction units such as house, flat, etc.

The investigator (researcher) must decide as to which one of such units he has to select for his purpose.

Sampling Frame

All rigorous sampling demands a subdivision of the material to be sampled into units, termed sampling units, which form the basis of the actual sampling procedure. For using methods in the collection of data, it is essential to have a frame at all the sampling units belonging to the population to be studied with their proper identification particulars and such a frame is termed the sampling frame. For example, in the sampling of a human population with households as sampling units, a list of households is the sampling frame. Similarly, in area sampling maps will serve as sampling frames. Sometimes these frames are in existence and can be readily obtained. Sometimes these have to be prepared at an extra cost before sampling. Sampling frames are very important and influence every aspect of a survey design - particularly sample design. Construction of a frame is often one of the major practical problems faced by the investigator. The readily available frames in general are inadequate, incomplete or partly illegible or may contain an unknown amount of duplication. The problem of inadequacy of a frame arises when it does not cover the whole of the population to be studied. A frame may be inadequate for one purpose and quite adequate for another. A frame is

incomplete when some of the population units are supposed to be on it are in fact not on it. Since these elements will have no chance of being selected, the sample will be unrepresentative of the population to that extent. Therefore, construction of sampling frame is very essential in sample surveys.

Errors in Surveys

The deviations of the study results from the true values are termed as errors. The different factors for these errors in surveys are:

i. data specification being inadequate and inconsistent with respect to the objectives of the study.

ii. omission or duplication of units due to imprecise definition of the boundaries of area units, incomplete or wrong identification particulars of units or faulty methods of enumerations.

iii. inaccurate or inappropriate methods of interview, observation or measurement with inadequate or ambiguous schedules, definitions or instructions.

(Errors due to the above three factors i-iii are known as specification errors).

iv. lack of trained and experienced investigators.

v. difficulties involved in actual data collection arising from recall errors and other types of errors on the part of respondents,

vi. lack of adequate inspection and supervision of primary staff,

(errors due to the factors iv-vi are known as ascertainment errors).

vii. inadequate scrutiny of the basic data.

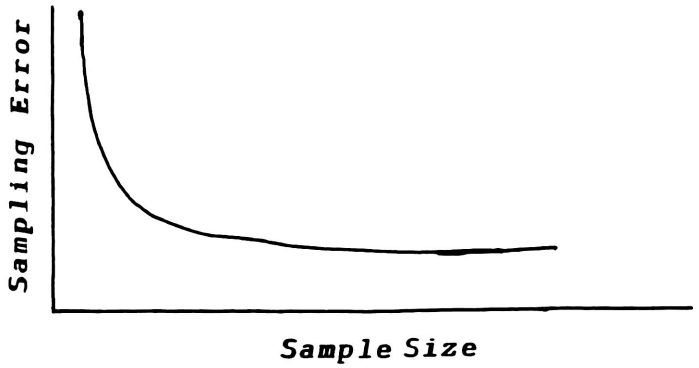
viii. errors in data processing operations such as coding, tabulation, etc. and

ix. errors committed during presentation and printing of tabulated results, graphs, etc. (errors to the factors vii-ix are known as tabulation errors).

The ascertainment errors and tabulation errors can be further classified as coverage errors and content errors.

The above mentioned errors do occur both in census surveys and sample studies and these errors are termed as non-sampling errors. In addition to these errors, in sample studies, another type of errors occur because of partial information based on the sample selected. These errors are called as sampling errors and these are inevitable.

The sampling error usually decreases with increase in sample size as shown in the following figure.



It is observed from the above figure that considerably greater effort is needed after a certain stage to decrease the sampling error than in the initial instances. Hence, after that stage, sizeable reduction in cost can be achieved by lowering even slightly the accuracy required.

From this point of view, there is a strong case for resorting to a sample study to provide values within permissible margins of error instead of complete enumeration. As regards the non-sampling error, it can be easily seen that it is likely to be more in the case of a complete enumeration than in the case of sample study, since it is possible to reduce the non-sampling error to a greater extent by using better organisation and suitably trained personnel at the field and tabulation stages in the sample study than in the census study. The behaviour of the non-sampling error with increase in sample size is likely to be opposite of that of sampling error. That is, non-sampling error is likely to increase with increase in sample size. In many situations, it is quite possible that the non-sampling error in a complete enumeration is greater than both the sampling and non-sampling errors taken together in a sample study, and naturally in such situations, the latter is to be preferred to the former. A sample study may also become a necessity in dealing with characteristics where serious non-sampling errors are expected, when special precautionary measures cannot be taken during collection and tabulation of data.

Estimates

A sample study has two important objectives: (i) estimation of certain parameters of a population and (ii) testing of certain hypotheses. The procedure of obtaining a value for the parameter on the basis of a sample

observation is known as estimation. The value obtained by such procedures based on a particular sample is known as estimate of that parameter. For example, to find the population mean we can use the sample mean. Here the mean of the sample selected is the estimate of the population mean. The difference between the estimate and the parameter value is termed as sampling error. Suppose t is an estimate and 2 is the parameter. In this case the sampling error is expressed as the difference of t and 2. From sample to sample 't' takes different values. If 2 is equal to the average value of t, then the average of squares of deviations of t values (based on all possible similar samples) about 2 is known as the sampling variance of t. The positive square root of sampling variance is known as standard error of that estimate and usually denoted by σ_t. If t is the mean of a simple random sample with replacement then the standard error (se) will be equal to $\sqrt{\sigma^2}/n$ where σ^2 is the population variance and n is the sample size. Similarly, the standard error of 't' in case of random sampling without replacement will be

$$\sqrt{\frac{N-n}{N-1}}\,\frac{\sigma}{\sqrt{n}}$$

The measure of standard error is based on the deviations of the estimate and parameter, sampling error will be expressed in terms of standard error. It is observed that standard error decreases with increase of sample size.

To decide the sampling method, the measure of standard error of the estimate is essential as mentioned earlier. The method which will have smaller standard error will be preferred normally.

Confidence Limits

The standard error gives an idea of the frequency with which errors of a given magnitude may be expected to occur if repeated random samples of the same size are drawn from the population. From a knowledge of the standard error of the estimate and with the help of the normal probabilities, we can locate the actual unknown value of the parameter within certain limits with a known probability. Take the example of estimating the population mean. We know that the mean of a random sample will be approximately normally distributed if the size of the sample is not too small and if the population from which it is drawn is not very different from the normal distribution. We may, therefore, expect that

$$\left| \bar{Y}_n - \bar{Y}_N \right| \leq \frac{\sigma}{\sqrt{n}}$$

on an average in 68 out of 100 occasions, and

$$\left| \bar{Y}_n - \bar{Y}_N \right| \leq 2 \frac{\sigma}{\sqrt{n}}$$

on an average with a frequency of about 95 out of 100. (Here $\bar{Y}_n$ is the sample mean, $\bar{Y}_N$ is the population mean, σ^2 is the population variance).

In general, we can expect the interval

$$\left[\bar{y}_n - Z_\alpha \frac{\sigma}{\sqrt{n}} , \bar{y}_n + Z_\alpha \frac{\sigma}{\sqrt{n}} \right]$$

To contain population mean $\bar{y}_N$ with certain probability. Here the probability depends on the value of Z . This type of interval which is likely to contain the population value with certain probability is known as confidence interval for that population value based on the sample drawn. Concept of confidence interval is very useful in fixing the sample size in probability sampling is described earlier.

Sample Size

How large should the sample be ? This question can be answered according to a prescribed list of sampling ideals. For most practical research projects, it is often difficult to satisfy these sampling ideals by offering a predetermined set of blanket generalisation covering all aspects of how one should sample. The limitations of money, facilities, and staff are enough to jar any investigator into the position of doing the best with what he has, even though it is far from what he would want to do ideally.

An adequate sample is one that contains enough cases to insure reliable results. Hence planning in advance for the size of the sample is very important. Several rules of thumb exist for estimating how large a sample should be. The most common is to obtain 1/10th of the population he

studies in his sample. But there are other better methods, one being the following.

The determination of sample size depends upon the desired precision and cost. Normally one of these will be fixed to find the suitable sample size to draw the sample units. The precision is usually specified in terms of the margin of error permissible in the estimate and the coefficient of confidence with which one wants to make sure that the estimate is within the permissible margin of error. Thus, if the error permissible is the estimate of the population value of the mean is say D and the degree of assurance is α, then clearly we need to know the size of the sample, n so that

$$P\left\{ |\bar{y}_n - \bar{y}_N| \leq D \right\} = \alpha$$

Where $\bar{y}_n$ is the sample mean based on n observations and $\bar{y}_N$ is the population mean. The above statement can be written as

$$P\left[\frac{|\bar{y}_n - \bar{y}_N|}{\text{S.E.of } \bar{y}_n} \leq \frac{D}{\text{S.E.of } \bar{y}_n} \right] = \alpha$$

(here S.E. of y_n means standard error of y_n).

But $\dfrac{\bar{y}_n - \bar{y}_N}{\text{S.E. of } \bar{y}_n}$ is a standard normal variate and therefore, for any given α, we can obtain normal value, say Z from the normal table satisfying the above equation.

Hence

$$Z_{\alpha} = \frac{D}{\text{S.E. of } \bar{y}_n}$$

We know that in case of simple random sampling with replacement the standard error of $\bar{y}_n$ is equal to $\sigma/\sqrt{n}$ and therefore,

$$Z_{\alpha} = \frac{D}{(\sigma/\sqrt{n})}$$

or

$$n = \frac{Z_{\alpha}^2 \sigma^2}{D^2}$$

Here the values of σ^2 will be obtained with previous knowledge or through pilot study. In this way, we can find the sample size, so as to keep the error in the desired limits.

So to apply the formula for estimating sample size we must know the following things:

a) The level of confidence or the level of significance.
b) The tolerance error we will be wiling to permit in the sample size estimate.
c) Some estimate of the sample standard deviation, a measure of variability or dispersion.

Suppose the cost is fixed at C. Now we can write $C = C_0 + C_1 n$ where C_0 is the overhead cost in conducting the sample survey and C_1 is the average cost to deal with the sample units. Therefore,

$$n = \frac{C - C_0}{C_1}$$

C_0 and C_1 can be estimated with the past experience or through pilot survey. Here C_1 contains the cost of collection, tabulation, loss due to the decision based on error, etc.

Therefore, while deciding the sample size, generally we should try to minimise both sample error and non-sampling errors (errors occurring during the collection, analysing the data etc.).

Sampling Method

The choice of the method of selection of a sample is generally based on the sampling error. Sometimes, the sample will be selected on the prior knowledge and past experience and at other times based on the theory of probability. The sample selected on the basis of probability theory is known as probability sample and otherwise it is known as purposive sample or non-random sample. The distinct advantage with probability sampling is that statistically valid methods of drawing inferences about the population can be developed. With non-probability samples the conclusions refer only to the sample, and not to the population. There are different probability samples. For example (i) random sampling (with or without replacement), (ii) stratified random sampling, (iii) systematic random sampling, (iv) cluster sampling, etc. The different common non-random sampling procedures are (i) systematic sampling, (ii) quota sampling,

(iii) purposive sampling, (iv) judgement sampling, (v) convenience sampling or chuk sampling, (vi) accidental or incidental sampling, (vii) snowball sampling.

Nature of the survey, size of the population, size of the sample, availability of funds, time and other resources would influence the selection of a particular method. However, the selection of probability sample once again depends upon the smaller sampling error.

For the benefit of the readers, a brief outline of each of the above sampling methods is given in the following paragraphs.

Random Sampling

A method of selecting sample units such that each possible sample has a fixed and determinate probability of selection is known as random selection. In random selection, if each possible sample has equal probability of selection then the method is known as simple random sampling and the sample so obtained is simple random sample.

A simple way of obtaining a simple random sample is to draw the units one by one from the population units with equal probability of selection assigned to each unit of the population at the first and each subsequent draw. The successive draws may be made with or without replacing the units selected in the preceding draws. The former procedure is called the simple random sampling with replacement and the latter is random sampling without replacement. Suppose 'n' units are to be selected from 'N' units of the

population. In case of with replacement, the probability of drawing each unit of the population is equal to the reciprocal of the number of units in the population, i.e. 1/N. Similarly in case of without replacement, all the units in the population will have the probabilities of first, second, ... Nth draw are 1/N, 1/N-1, ..., 1 respectively. Random sampling will be done either by (i) a lottery method (or fishbowl method), (ii) a table of random numbers and (iii) computer-determined random sampling method. Because of their easiness and convenience second and third methods will be preferred.

Generally, simple random sampling procedures will be preferred because

i. the amount of sampling error associated with any given sample drawn can easily be computed,
ii. the investigator (or researcher) does not need to know the true composition of the population before hand,
iii. this method is used in conjunction with all other probability sampling plans and
iv. of all probability sampling plans, this method is the easiest to apply.

Stratified Random Sampling

To get a representative sample, the entire population will be divided into homogeneous groups or classes based on certain characteristics before selecting a random sample from each of these subgroups. These subgroups are called strata and the combined sample obtained by this method is

known as stratified random sample. A stratified sample is thus equivalent to a set of random samples of a number of such populations, each representing a single type or stratum.

A stratified random sampling may be either proportionate or disproportionate. In a proportionate stratified sampling, the number of items drawn from each stratum is proportional to the size of the stratum (number of units in that stratum). On the other hand, if an unequal number of units are drawn from each stratum regardless of how the stratum represented in the population, then such a sample obtained is known as disproportionate stratified sampling.

The primary use of disproportionate stratified random sampling is when elements exist few in number among certain strata. If there is a strong likelihood that one or more strata will not be included in the simple random sample of elements (i.e. some strata exist in so few numbers that it is quite likely that elements from strata will not be drawn), then the researcher should take steps to see that elements from those particular strata will be included. This detracts from the randomness of the draw, however, and to that extent is less a probability sample than before. The researcher exercises his judgement as to whether the particular strata is important enough so that steps should be taken to ensure that elements from it are included in subsequent sample. When the population under investigation

can be stratified according to some characteristic with which the investigator has some familiarity, it is usually amenable to disproportionate stratified random sampling. However, while using disproportionate stratified random sampling, the researcher should keep in mind the following.

In a given stratum, one should take a larger sample if

i. the stratum is larger.

ii. the stratum is more variable internally.

iii. sampling is cheaper in stratum (cost per sampling is less).

But generally, the relative variability and the relative costs in the strata are known before hand. However, these difficulties are overcome by using the information based on similar previous surveys or pilot surveys.

In most of the practical situations strata are the geographical regions or regions formed for administrative convenience or private and public institutions,etc. whenever strata are not readily available, they can be formed such that each stratum is sufficiently homogeneous with respect to some characteristic like age, sex, and profession. There is no general rule to decide the number of strata.

When compared to simple random sampling procedure, stratified random sampling procedure ensures greater reliability and validity of the survey results.

Systematic Random Sampling

A systematic sample is one in which very Kth unit (say 1 in 20 units) is selected in a list representing a

population. The number K is called the sampling interval. The units of population are arranged in systematic order on the basis of its important characteristics. The first number is chosen at random from the first K items. The value of K is approximately equal to the ratio of the number of units in the population and the size of the sample required (N/n). This is an easy procedure for an inexperienced investigator to follow. A systematic sample is usually more evenly spread over the entire population and thus can provide more information about the population than an equivalent amount of data contained in a simple random sample.

When K exceeds N/n, the number of observations (units) selected by the above procedure is less than n. In this case, we choose a random start from 1 to N and select units corresponding to this random start and thereafter every Kth unit in a cyclical manner till a sample of n units is obtained. This procedure of drawing a sample is known as Circular Systematic Sampling.

The systematic sampling is generally used in those cases where a complete list of the population from which the sample is to be drawn is available. The operational simplicity of systematic random sampling over simple random sampling is of considerable importance in large scale sampling. Systematic sampling is not advisable when the data is periodic. If the starting value is not chosen randomly then we call the procedure systematic sampling and this will be considered as non-probability sample.

Cluster Sampling

Cluster sampling involves division of the population units under consideration into groups or clusters that serve as primary sampling units. A selection of the clusters is then made to make up the sample. Thus in cluster sampling, the sampling unit contains groups of units instead of individual units in the population. For example, for the purpose of selecting a 10 per cent sample from all primary school children in Delhi, the investigator may list up all the primary schools and select randomly a 10 per cent of schools. All the children in these selected schools are the units for enquiry.

Sometimes each cluster is further subdivided into sub-clusters and from each cluster some sub-clusters are selected to form sampling units. This procedure is known as two stage cluster sampling.

If the population units are geographical areas, cluster sampling is more appropriate and accordingly cluster sampling is also known as area sampling.

Cluster sampling is much easier to apply when large populations are studied for when large geographical areas must be covered. The cost of area or cluster sampling is much less compared with other sampling methods. In a multi-stage cluster sampling, it is possible to employ different forms of sampling in several successive stages.

There is a larger sampling error associated with cluster sampling.

Public opinion polls are frequently conducted using cluster sampling. When lists of specific individuals are unobtainable or inaccessible, cluster sampling is recommended.

Multistage Sampling

The above methods we have covered are the simplest probability sampling procedure. In most real applied social research, we would use sampling methods that are considerably more complex than these sample variations. The most important principle here is that we can combine the simple methods described earlier in a variety of useful ways that help us address our sampling needs in the most efficient and effective manner possible. Such combine sampling method are known as multistage sampling. For example, in cluster sampling procedure, we may select the units from each cluster by stratified sampling procedure.

Non-Probability Sampling

Quota Sampling

Quota sampling is defined as obtaining a desired number of units by selecting those most accessible to the investigator and those that possess certain characteristics of interest to him. This sampling method is considerably less costly than most other sampling methods and this method is satisfactory when quick, crude results will satisfy the research objectives of the investigator. But generalisation to population is not possible based on quota sample.

Purposive Sampling

The researcher purposefully selects and also purposefully leave units while selecting the sample units based on the objectives and other reasons. This method is suitable when there are only a small number of sampling units in the population. It is most suitable in urgent surveys.

Judgement Sampling

A judgement sample is one which is selected mainly on the basis of experts' opinions. For example, if a sample of five students is to be selected from a class of forty for sampling the study habits of students, the investigator would select five students with the help of class teacher. In certain situations these methods are preferred over simple random sampling. The purposive and quota sampling procedures from part of judgement sampling. Judgement samples are less costly and more readily accessible. They are also guaranteed inclusion of relevant units.

Convenience Sampling

Selecting 'convenient' population units is called convenience sampling. A sample obtained from readily available lists such as automobile registrations, telephone directories, etc. is a convenience sample. The results obtained by this method can hardly be representative of the population. They are generally biased and unsatisfactory. However, convenience sampling is often used for pilot studies.

Accidental or Incidental Sampling

Accidental or incidental samples are identical to quota samples with the following exception. Whereas quota samples attempt to include units possessing apparent characteristics, accidental samples make no such attempt. The investigator is guided mainly by convenience and economy. For example, the investigator may consider the first 50 persons who are willing to be interviewed or to provide the kind of information that he is seeking, he meets on any one of the pedestrian paths of a street. Where too much accuracy is not needed or where pre-occupation with tentative clues to hypothesis-formulation (in exploratory surveys), accidental sampling is quite useful.

Snowball Sampling

In snowball sampling, we begin by identifying someone who meets the criteria for inclusion in our study. We then ask them to recommend others who they may know who also meet the criteria. Although this method would hardly lead to representative samples, there are times when it may be the best method available. Snowball sampling is especially useful when you are trying to reach populations that are inaccessible or hard to find. For instance, if we are studying the homeless, we are not likely to be able to find good lists of homeless people within a specific geographical area. However, if we go to that area and identify one or two, we may find that they know very well who the other

homeless people in their vicinity are and how we can find them.

No doubt, non-probability sampling method has several weaknesses and many experts do not recommend it. Even then, in certain situations it becomes essential to follow this sampling and in some cases it is preferred over probability sampling. Following are a few examples of such cases:

i. when the sampling frame is either not available or incomplete (ex: selection of unrecognised schools),
ii. when the sample size is very small,
iii. when in a pilot survey tryout of a questionnaire or a set of tools is required,
iv. when the field work has to be done quickly in order to reduce memory errors,
v. when reactions of an affected group of persons (from floods, riots, etc. are required,
vi. to assess the reaction of audience to some film or exposure audio-visual programme, a sample is needed.

Reference Books

1. ARLENE FINK: How to conduct surveys - A step by step guide.
2. ARLENE FINK: The Survey Handbook.
3. W.G. COCHRAN: Sampling Techniques.
4. W.E. DEMING: Sample Design in Business Research.
5. FRANK YATES: Sampling Methods for Consuses and Surveys.
6. L. KISH: Survey Sampling.
7. KUMAR, A.: Social Research Method.
8. LOKESH KOUL: Methodology of Educational Research.
9. MORRIS H.HANSEN AND OTHERS: Sample Survey Methods and Theory.
10. M.N. MURTHY: Sampling Theory and Methods.
11. RONALD CZAJA AND JOHNNY BLAIR: Designing Surveys - A Guide to Decisions and Procedures.
12. SEYMOUR SUDMAN: Applied Sampling.
13. SIR CLAUS MOSER AND GRAHAM KALTON: Survey Methods in Social Investigations.

NATURE AND TYPES OF VARIABLES

Section I

1. What is the meaning of 'variables' in educational research ?
2. Why are educational researchers interested in variables ?

While trying to find answers to these questions, a good starting point is a short passage from Ary D. et al. (1979).

> A variable is an attribute, which is regarded as reflecting or expressing some concept or construct. A variable takes on different values. Height is one example of a variable; it can vary in an individual from one time to another, between individuals at the same time, between the averages for groups,and so on. Social class, sex, vocabulary level, intelligence quotient, and spelling test scores are other examples of variables.(Ary et al.,1979,p.28).

The above passage is a good exposition regarding the concept and meaning of variables in the context of research in social sciences in general and research in education in particular. After analysing this passage and going deeper still, the following points emerge.

Key point 1

In educational research, a variable stands for a characteristic or property of human beings, institutions,

educational programmes, teaching-learning aids or any other aspect of education.

Examples of variables

Pertaining to:

Human Beings	Variables
1. Students	1. Achievement in Language, Science, Maths, 2. Intelligence, 3. Interest, 4. Attitude/Opinion towards ... 5. Motivation, 6. Memory-short term, long term, 7. Self-concept or Self-esteem, 8. Social adjustment, 9. Anxiety, 10. Moral sense, 11. Creativity, 12. Problem-Solving ability, 13. Cognitive style, 14. Socio-economic status, 15. Age 16. Language achievement: Listening, Speaking, Reading, Writing-Writing, Spelling, Grammar, Structure, Paraphrasing, etc.
2. Teachers	1. Many of the above, 2. Teaching skills: Communicating (verbal, non-verbal), blackboard writing, introducing a lesson, reinforcing, questioning skill, etc. 3. Teacher-effectiveness as measured by ..., 4. Teaching-style/method, 5. Interaction with students, 6. Job-satisfaction, 7. Attitude towards H.M., colleagues, 8. Qualifications, 9. Teaching experience, etc.
3. H.M., Subject Inspectors	Several of the above plus leadership qualities
4. Parents	Education, Occupation, Income: SES Attitude towards education of children, towards curriculum, school practices, etc.

Variables pertaining to

Educational Institutions	Variables
1. School	Staff school facilities:Laboratories, Library, Playground, Toilet, etc.
2. Teacher-training institution	School climate, school type, location faculty position (number, qualification) facilities
3. DIET	School climate, school type, location faculty position (number, qualification) facilities

Variables pertaining to

Educational programmes	Variables
1. Language curriculum, Science curriculum, Maths curriculum	Organisation, Transaction, Effectiveness
2. Primary Education Programme	Effectiveness, Implementation
3. Incentives Programme (mid-day meals, money/ rice for attendance,etc.)	Effectiveness
4. Innovative Practices	Learning in children, other outcomes
5. Teacher-training programmes	Effectiveness/Impact on classroom practices, Attitudinal change, Improved understanding of educational concepts.
6. Educational T.V.	
7. Computer Software	
Teaching-Learning Aids	
1. A.V. Aids	Effect on students' learning, motivation, memory, etc.
2. Models	

A perusal through the above list will make it clear that a variable does not stand by itself; it is always associated with persons, institutions, events or objects in the educational setting. Thus the meaning of key-point 1 becomes clear.

But the meaning of 'variable' will be complete only when we introduce the third element: values of the variable.

Examples

Reference of the variable/ The variable is a property of:	Variables	Possible values
Students	Achievement in Science	Student A: 52/100 marks B: 40/100
	Age	Student A: 10 yrs 6 mon 10 1/2 years B: 11 years
	Sex	Student A: Male B: Female
	Socio-Economic Status (SES)	Student A: Low B: High C: Medium
Teachers	Content competence - Social Studies, Maths or any subject	Teacher A: 35/100 B: 57/100
	Attitude towards	Positive, Undecided, Negative
	Job satisfaction	Very satisfied, Satisfied, Partly satisfied, Not satisfied
	Teaching Experience	Above 20 yrs / Between 10 & 20 / Less than 10 yrs
School	Type	Govt. / Pvt. Aided / Pvt.
	Location	Urban, Semi-urban, Rural, Tribal
	Physical facilities	Very good, Good, Poor, Very poor
	School climate	Authoritarian, Democratic, Permissive

Thus a variable means all three elements: the reference of the variable, the variable itself, the possible values of the variable and actual values obtained/assigned after assessment. In case of some variables like age, height, the fourth element unit also should be stated, eg. height in feet/inches or in centimeters.

Please note another thing regarding the values of the variable: some values are expressed in numbers (numerical variables); some values are expressed in words (categorical variables) - 2 options, 3 options or 4. This topic to be discussed later.

Key Point-2

A variable stands for a characteristics or property. The property changes over time and takes on different values. In other words, the value of the variable changes or varies:

1. in an individual from one time to another.
2. between individuals at the same time.
3. between the means of groups:
   a. change in the means of the same group when measured at different times.
   b. change in the means of two or more groups when measured at the same time.

Examples:

Ex.for (1) The intelligence score of Sudhir in Jan 1998 (5 years age): 95 Int. score in Jan. 1999: 105.

There is an increase of 10 in one year in the same individual.

Ex.for (2) Science achievement test scores on 15-3-1999:

Class IXA Max. Marks: 50

Student	A. 30	D. 15
	B. 27	E. 40
	C. 32	F. 25, etc.

The same test is given on the same day to 40 students of the same class/same group, taught by the same teacher. Yet the variable (science achievement) takes on different values in different students.

Ex.for (3) Mean of the marks in the above test:

(b) Class IXA - Mean 26

Class IXB - Mean 30

The same test is given to two classes on the same day. But the means differ.

Ex.for (3) (a) Class IXA

Pre-test mean: 24 Post-test mean: 29

Equivalent forms of the same test (science test Form A: Pre-test, science test, Form B: Post-test) are gievn to 9th class students before and after special construction of two months duration.

We notice three things: The reference of the variable, the variable itself and the value of variable.

A careful observer/reader of the above values of the variables, will notice the change (increase or decrease) in the values of the variables.

Questions may arise: Why are the values of the variables higher for some students, lower for others ? What is the reason/cause for the high mean performance of class IXB over IXA ? Is it because of the better teaching skills/method

of the teacher of IXB or because the students are more intelligent or they studied harder ? There is no straight answers to these questions pertaining to events which go on in the classrooms. But some answers can be found if educational research is conducted in the proper manner. To conduct research a proper understanding of variables is required.

Key point 3

Educational researchers are interested in (a) observing the changes in the characteristics occurring over time, (b) in measuring or evaluating them and (c) in finding relationship between them.

The educational researcher spends a considerable amount of his time in doing these three things. But the third is possible only if the first two are done properly.

The meaning of key-point 3 will become clear only when you re-read and reflect over key-point 2 and its elaboration.

Questions/Exercises

I. Say whether the following statements are true or false by putting a circle around T or F.

1. Motivation is a variable pertaining to educational institutions. T/F
2. Attitude towards children's education is a variable pertaining to students. T/F
3. The value of a variable may vary from one time to another or it may vary among individuals at the same time. T/F

4. The meaning of a variable is clear and complete if we know its name without any additional information. T/F

5. Through educational research it is possible to study only the variables pertaining to teachers, not the variables concerned with their training programmes. T/F

II. Give examples for the following:

1. Four variables pertaining to students.
2. Aspects of variables in which educational researchers are interested.
3. A variable which takes on different values for three groups measured at the same time (Give group measures, not individual measures).
4. An attribute or property of human beings which does not change with time.
5. Possible questions which may arise in mind after observing the three values in (3) above.

III. Imagine you are one of the two teachers teaching the three groups in situation (3) above. Write down the possible answers which you can give in response to the questions raised under item (5) above.

Section IIA

1. What are the different types of variables in educational research ?
2. What type of variables are usually found in an important type of educational research called Experimental Research?

While considering the above questions, a good starting point is to consider Experimental Research. The

concept and types of variables in experimental research are discussed by Best and Kahn (1993) as follows:

> Variables are the conditions or characteristics that the experimenter manipulates, controls or observes. The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his or her attempt to ascertain their relationship to observed phenomena. The dependent variables are the conditions or characteristics that appear, disappear or change as the experimenter introduces, removes or changes independent variables (Best and Kahn, 1993, p. 137).

The definitions and meaning of variables in experimental research given above find parallel expression in the following two extracts from Ary et al. (1979) which speak about experimental research and the variables involved.

> There are three essential ingredients with which the scientist is actively involved in the conduct of an experiment:control,manipulation and observation (Ary et al., p. 228).
>
> In its simplest form an experiment has three characteristics: (1) an independent variable is manipulated; (2) all other variables except the independent variable are held constant(controlled); (3) the effect of the manipulation of the independent variable on the dependent variable is observed (measured). Thus in an experiment the two variables of major interest are the independent

> variable and the dependent variable. The independent variable is manipulated or changed by the experimenter. The variable upon which the effects of the changes are observed is called the dependent variable, which is observed but not manipulated by the experimenter (Ary et al., 1979, pp. 225-226 ... the two words under brackets in (2) and (3) inserted by me).

By going through the presentations given by the authors of the two books, it is clear that they speak similar language. Note, for example, the use of the words 'manipulate, controls or observes' in the definition of variables (in the context of experimental research) given by Best and Kahn - an echo of the same words found in Ary and co-authors p.228. In fact these three terms are very crucial for a clear understanding of the meaning and process of experimental research (another major topic on which my colleague will elaborate). But the concept of dependent variable (DV) and independent variable (IV) can be understood properly only if you have understood experimental research properly.

A simple example will illustrate the meaning of the terms DV and IV. A researcher wants to find out whether the Activity Method of teaching Science will be more effective in achieving science learning in students of class 8, than the Lecture-demosntration method. Here the variables are:

Dependent Variable (DV) (to be observed/ measured)	: Achievement in science of standard 8th standard students
Independent Variable (IV) (will be manipulated by the experimenter)	: Method of teaching science: Activity Method and Lecture-demonstration method

Other IVs (to be controlled by the investigator)	: Intelligence of class eight students. SES of class eight students

Thus we see all the three essential ingredients playing a part in this particular experimental research: manipulation of the selected IV, control of other relevant IVs which may exert influence on the DV, and observation/ measurement of the DV.

This is only a simple case of experimental research. Complex cases are possible where two IVs are manipulated simultaneously and their effects on the DV are measured (Robinson, 1976, pp. 237, 240).

The above experiment is simple (the simplest in another sense: there are only two groups subjected to the manipulation of the variable:

Group 1 is taught science using Activity method

Group 2 is taught science using the Lecture-demonstration method

Method of teaching (science) is considered as one variable, but under it there can be two methods/two groups, three methods/three groups, and so on. Often in two groups - design, one is called the Experimental Group, the other the Control Group.

Analysis

The mean scores of Science Achievement (the DV) of the two groups are compared to find out which group has done better. But the better performance of one group over the other will be attributable to the method used in that group

only when the two groups have been equated (to the extent possible) on the other IVs like intelligence and SES. This is called control of other variables. A statistical test (t-test) will be used to find out if the difference is significant and applicable to the population.

Other terms used for the independent variable which is manipulated: Treatment variable or Experimental variable (Best and Kahn, 1993, p. 137).

Other Examples

1. Aim of experimental research:

   To find out the effect of using Programmed Instruction (PI) materials on the mathematics achievement of class VI students.

   DV: Achievement in Mathematics

   IV (manipulated): Method of teaching maths

   Method 1: teaching maths with the usual text-book.

   Method 2: teaching maths with PI materials based on the mathematics curriculum of class VI.

   Other IVs (to be controlled): Intelligence of students, their socio-economic status, etc.

2. Aim: To investigate the efefct of co-operative learning approach in the social studies classroom.

   DV: Achievement in social studies

   IV (manipulated): Instructional method

   Method 1: Teaching social studies to 40 students in the usual way: Teacher to students.

   Method 2: Teacher gives introduction/topic of the day for 10 minutes and for the remaining 30 minutes students are allowed to work in groups of 5 regarding the topic.

   Other IVs (to be controlled): Intelligence, SES, sex (boys/girls), etc.

In the examples above, the researcher assumes that better learning of subject (the DV) may result from the novel method of teaching/classroom arrangement (the IV). In this process, the influence of other IVs on the DV are controlled to the extent possible.

Questions/Exercises

I. What is meant by the following terms ?

1. Independent variable, Dependent variable, Treatment variable, Manipulation of variable.
2. Go through the list of variables in section 1. Think of an experimental research involving students. Specify the DV, the IV which will be manipulated and the IVs which will be controlled.
3. Do a similar exercise regarding teachers (primary or high school). Specify the variables: the DV, the IV to be manipulated and the IVs to be controlled.

Section IIB: Further classification of variables

To examine and understand further different types of variables used in educational research, the following quotations are useful:

> <u>There are two types of independent variables:</u> Treatment and organismic or attribute variables. Treatment variables are those factors that the experimenter manipulates and to which he or she assigns subjects. <u>Attribute</u> variables are those characteristics that cannot be altered by the experimenter. Such independent variables as age, sex and race have already been determined, but the experimenter can decide to include them or remove

them as variables to be studied (Best and Kahn, p. 137).

The term attribute variable is more common than 'organismic' variable. Another alternate term for the same thing is categorical variable which is defined and explained by Ary et al. as follows:

> When subjects are classified by sorting them into groups, the attribute on which the classification is based is termed a categorical variable. Home language, country of residence, father's principal occupation, and school in which enrolled are examples of categorical variables. The simplest type of categorical variable has only two classes and is called a dichotomous variable. Male-female, citizen-alien, pass-fail are dichotomous variables. Some categorical variables have more than two classes; some examples are educational level, religious affiliation, state of birth (Ary et al., 1979, p. 28).

The above quotation is self-explanatory. Categorical variables with three classes are also called trichotomous variables. Examples are Type of schools:Government, Private-aided, Private Teachers: Married, Single, Divorced.
Attitude: Positive, Undecided, Negative

Favourable, Indifferent, Unfavourable

These categorical variables are also called attribute variables. In contrast to these categorical variables, the other variables are numeric variables since one numeric variable can have many numbers as their values - science

achievement (of 50 students) will have 50 numbers, one number for each student. But a categorical variable like sex will have only two values - all 30 students will have the same value 'boys' and all the 20 students will have the other value 'girls'.

The following diagram illustrates different types of variables in educational research.

A. Variable --> Reference of the variable

--> Name of the variable

--> Value of the variable
(and unit in some cases)

B.

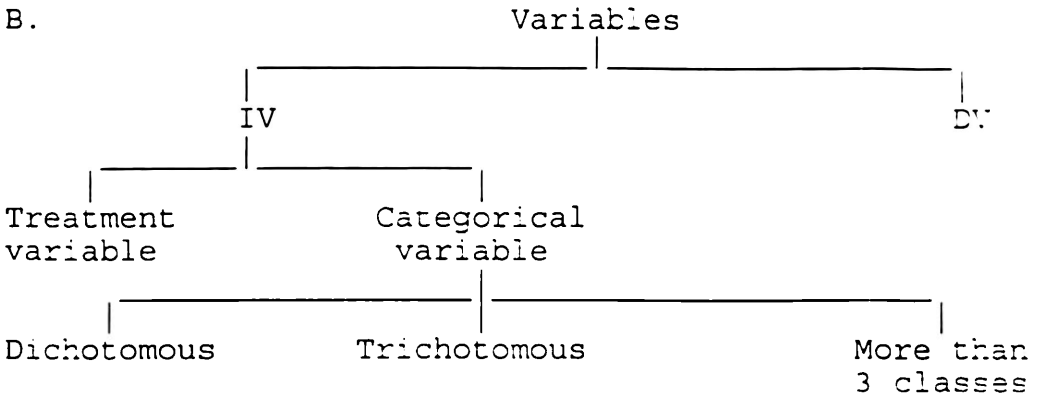


Fig. 1: Classification of Variables

Does the researcher have choice in selecting the number of classes/categories pertaining to categorical variables ? Answer: No and Yes.

No in the case of classes in nature/physiology:

Sex: Male/Female only.

Handedness: Right-handed/Left-handed

Result: Pass/Fail (If 'withheld' is included it becomes trichotomous)

Blood group: Only four classes: A, B, AB and O

Regions: Rural, Semi-urban, Urban, Tribal

Caste: SC, ST, OBC, Foreward

The answer is yes in those cases where the researcher is free to exercise his choice according to the needs/ objectives of his research and according to the data which he has gathered.

Eg: Socio-Economic Status (SES)

Students may be grouped into three categories or four.

A. High SES	B. Very high SES
Medium SES	High SES
Low SES	Medium SES
	Low SES

Similarly, intelligence-level of students: Three or four categories.

Options in a questionnaire, in Attitude Scale.

C. Agree	D. Strongly agree
Undecided	Agree
Disagree	Undecided
	Disagree
	Strongly Disagree

A and C are examples of responses on a 3-point scale for the categorical variable socio-economic status and attitude respectively. On the basis of the choices made by the respondents, they will be categorised into three groups or classes. B and D are examples of categorical/attribute variables with 4 and 5 values.

But while deciding the number of categories the researcher should put forward his reasons/the rationale for selecting a particular number and explain the cut-off points used for grouping and the appropriateness of the grouping scheme used by him/her.

Note: In Ex Post Facto (EPF) research, there is no manipulation of the independent variable. Variables like sex, social class and religion have already exerted their influence on persons, they cannot be manipulated. Thus the EPF researcher tries to explore the influence of such variables (IVs) on a particular numerical variable (DV) which he measures while controlling other IVs to the extent possible through research design. Several other aspects are common between Experimental Research and EPF research. Hence whatever has been stated regarding Eperimental Research should be suitably modified for designing and executing EPF research. Whatever be the type of educational research one is doing, it is necessary to have a clear idea of the variables to be selected, the tools for collecting data regarding the variables, the relation between variables and the required analysis.

Variables and Measurement Scales

Thus we have different types of variables based on the base on the scale of measurement used.

1. The numeric variables in behavioural sciences are assumed to be measured on interval scale akin to the internal scales used in the physical sciences for measuring length, mass, time, current and physical quantities (In the exact sciences they also use ratio scales with a point for true zero as in the absolute scale of temperature). But when we compare the accuracy of physical measurements, the measurements in education and psychology are crude. The efforts should continue to make more precise tools to measure variables like

intelligence, achievement, motivation, self-concept and attitude which are abstract intangibles open to diverse meanings and interpretations.

2. The second scale of measurement is presented now: the ordinal scale, where persons or objects are ordered on the basis of a variable.

Examples

Ten students have written ten poems or made 10 paintings. Judges have ranked them 1, 2, 3, ..., etc. upto rank 10 based on some criteria. Here the values of the variable (literary ability or painting ability) are expressed in ordered numbers, so that you know who is the first, the second, the fifth, etc. - the relative values of one person's ability with respect to the others.

If the interval scale were to be used in this measurement, the intrinsic values for each person could be known and a measure of the worth of his ability on a 20 point scale (or 50 point scale whichever used) would be available. But even if it is attempted, such a measurement may be open to questioning (subjectivity and other factors), hence the practice to make a ranking only.

3. The categorical variables or attribute variables discussed already are based on the nominal scale of measurement - 'nominal' means names, names for each group or category. Thus we give names to classifications of persons based on sex (boys,girls),personality (extrovert, introvert), height (tall, short), etc. Thus the third and lowest scale of measurement. The classifications may also be expressed using adjectival labels like High, Medium, Low, or verbal labels like Agree, Disagree, etc.

The classification of variables based on scales of measurement is shown through the following diagram (Fig. 2).

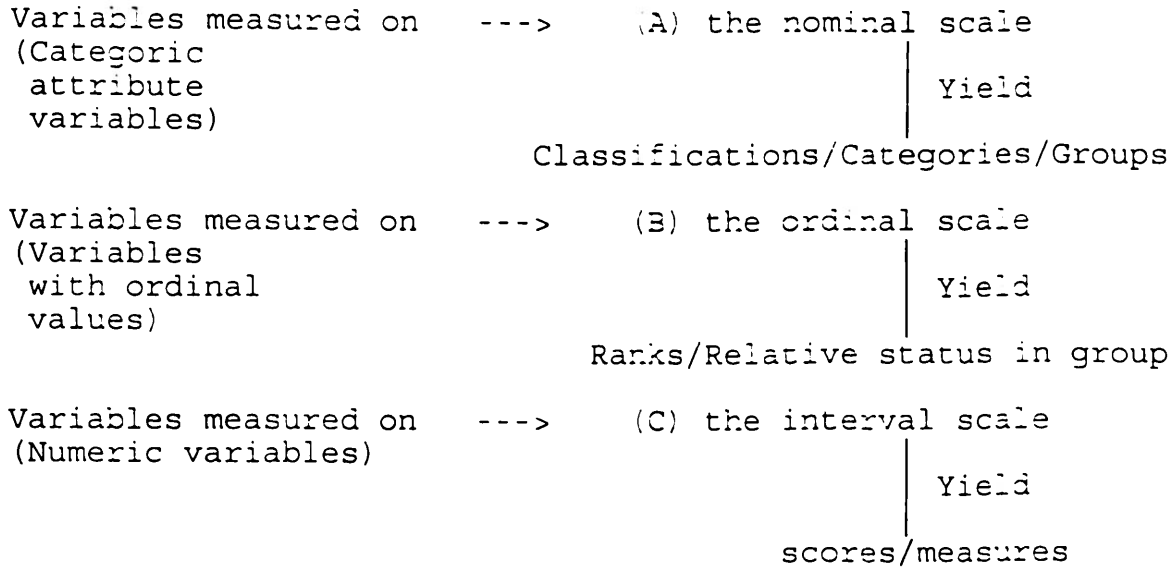


Fig. 2

Note that from the scores on the 3rd type of scale (interval scale) we can derive the second (B) and first (A) data types. If we have the scores of 60 students on language ability, it is possible to rank order them in merit. It is also possible to classify them into different categories: Good, Average, Poor. If we have ordinal scale data regarding some persons, it is possible to derive nominal scale data from them. But generating/transforming data in the reverse direction - from A to B, B to C - is not possible in most cases.

Questions/Exercises

1. Go through the list of variables and their values on page 4 and identify categorical variables and numeric variables.
2. Think of some variables like the following:
   1. Attitude of people towards politicians.

2. Opinion regarding the wearing of helmets while riding two-wheelers.
3. Opinion/attitude regarding mother tongue as medium of instruction.

A. Write down some more such topics/variables pertaining to (i) students, (ii) teachers, (iii) parents.

B. Imagine you are going to construct a questionnaire or opinionnaire to assess each such variable.

(i) Write down 2 or 3 samples of the questionnaire items for 2 of the topics which you have put down under A above.

This is a small exercise regarding the construction of a tool or instrument meant for gathering data regarding the variable.

(ii) Write down also the possible values of the categorical variable you are going to assess - a scale of three values, a scale of five values.

3. a) Give examples of educational variables based on the Ordinal scale, the Interval scale.

b) Differentiate between a variable measured on the ordinal scale and the interval scale.

4. a) Does the researcher have the freedom to fix the number of groups/values of all categorical variables ?

b) Do you have the freedom to choose the number of groups/values of some categorical variables ?

c) If your answer to (b) is yes, give some examples.

Section III: The Need to Define Variables

Very few of the variables used in educational research are clear and unambiguous (see page 4) like age (students, teachers), qualifications and teaching experience (teachers), occupation and income (parents), etc. Most of the other variables are not directly observable and measurable, but are constructs or concepts whose presence and magnitude can be only inferred through some sort of measuring. Vagueness and multiple meanings/interpretations creep into discourse when people talk about abstract entities like intelligence, learning, motivation, attitude, anxiety, social adjustment, cognitive ability, creativity, etc. Experts also differ on the meaning/definition which they attach to each of these terms and rightly so because these variables are not definable objectively as the concepts and ideas in science. If the variables selected for study by the investigator is open to such varied and multiple interpretations, it is his duty to select a particular meaning of the variable, use that meaning/ definition in his research and present the same meaning to his readers.

Two kinds of definitions are possible for each variable: (a) Conceptual definition or theoretical definition, (b) Operational definition.

Conceptual definition refers to the meaning given to the concept or variable on a theoretical basis by experts and professionals working in that area. There may be several conceptual definitions given by different experts each following a particular line or school of thought. Learning

is a classic example of how the S-R psychologists, the gestalt psychologists and the cognitive theorists (each with further subgroups) have defined, explained and researched it, each group in its own way. Similar is the case with Intelligence, Creativity, Problem-solving, Personality and other variables with multiple definitions.

Operational Definition

Best and Kalm (1993, p. 210) have this to say regarding operational definition:

In behavioural research, many of the qualities or variables of interest are abstractions and cannot be observed directly. It is necessary to define them in terms of observable facts, from which the existence and amount of the variables are inferred. This operational definition tells what the researcher must do to measure the variable. For example, intelligence is an abstract quality that cannot be observed directly. Intelligence may be defined operationally as scores achieved on a particular intelligence test.

The authors then go on to explain the limitations of operational definitions and the cautions to be exercised in their use.

The educational researcher may follow one of the courses of action outlined below (as a suggestion derived from research experience and reflection and not as a dictum or mandate handed down by an authority):

1. a) He may present a conceptual definition or two allied definitions of the variable from a dictionary/encyclopaedia of Education, of Educational Research, of Evaluation, of Curriculum or from the work of an

expert in the field. This may be done especially if his research variables are open to multiple meanings/ interpretations as stated already (Conceptual Definition).

b) He should also state an operational definition (in close agreement with the theoretical definition) as to how he is going to measure/assess the variable.

OR

2. a) Conceptual definition may be framed in his own words under the guide according to commonly accepted/understood meaning - in the case of less controversial variables like socio-economic status (students), locality (school),job-satisfaction (teachers . In such cases elaborate consultation of Dictionary of Education, etc. may not be necessary, though it is welcome and worth doing.

b) Furnish the operational definition of the variable which will be in agreement with the above-formulated definition.

OR

3. a) Present only the operational definition of the variable in the case of variables with clear meaning such as Achievement in subjects: language (mother tongue, second language), social studies (history, geography), science (as general science or as Physics, Chemistry, Biology), Mathematics (arithmetic, algebra, geometry) stating the conceptual definition in such cases may not be necessary.

So, depending on the problem selected for study and the variables involved, the researcher may do any one of the above or a suitable combination in the matter of defining the variables.

Questions/Exercises

1. While doing educational research, is there a need to define the variables ? Explain your answer.
2. Give examples for:
   (i) Variables subject to more than one meaning.
   (ii) Two or three definitions of a variable listed by you under (i). Consult proper references in the library.
   (iii) Some important sources in the library which may contain meanings, definitions of variables used in educational research.
3. (a) What is meant by operational definition of a variable ? State its usefulness and also some limitations.
   (b) Frame operational definitions of Achievement in two school subjects.
4. A researcher formulates his own definition for a variable in his research. Is it a correct or approved course of action ? Discuss.

References

1. Best, J.W. and Kahn, J.V.: Research in Education, Prentice Hall of India Pvt. Ltd., New Delhi, 7th Edition, 1993.
2. Ary, D., Jacobs, L.C. and Razavieh, A.: Introduction to Research in Education, Holt, Rinchart Winston, U.S.A., 2nd Edition, 1979.
3. Kerlinger, F.N.: Foundations of Behavioural Research, Holt-Saunders, Japan, Tokyo, 2nd Edition, 1973.

4. Slavin, R.E.: Research Methods in Education, Allyn and Bacon, M.A., U.S.A., 2nd Edition, 1973.

5. Kothari, C.R.: Research Methodology: Methods of Wishwa Prakashan, New Delhi, 2nd Edition (17th Reprint, 1997).

6. Robinson, P.W.: Fundamentals of Experimental Psychology, A Comparative Research, Prentice Hall Inc., Englewood Cliffs, New Jersey, 1976.

7. Kidder L.H. Selltiz et al.: Research Methods in Social Relations, Holt, Rinchart of Winston, Tokyo, 4th Edition, 1981.

REFERENCES

Carr, W. and Kemmis, S. (1986) Becoming Critical: Education, Knowledge and Action Research. Lewis Sussex: Falmer Press.

Dewey, J. (1910) How we think. Boston D.C. Heath.

Ebbutt, D. (1983) Educational action research: Some general concerns and specific quibbles. Cambridge Institute of Education.

Elliott, J. (1991) Action Research for eduational change. Milton Keynes. Open University Press.

Elliott, J. (1981) Action Research: A frame work for self-evaluation in schools:Cambridge Institute of Education.

Hovda, R. and Kyle, D. (1984) Action research:A professional possibility. Middle School Journal (May).

Kemmis, S. and McTaggart,R. (Eds) (1982) The Action Research Reader. Geelong, Victoria: Deakin University Press.

Lewin, K. (1947) Frontiers of group dynamics: II. Channels of group life; Social planning and action research. Human Relations, Ii.

Lieberman, A. and Miller, L. (1984) School improvement: Themes and variations. Teachers College Record, 86(1) (Fall).

Lippitt, R. and Radke,M. (1946) New trends in the investigation of prejudice. Annals of the American Academy of Political and Social Sciences, Vol. 244.

McKernan, J. (1988) The countenance of curriculum action research: traditional, collaborative and critical-emancipatory conceptions, Journal of Curriculum and Supervision, 3(3), Spring.

McTaggart et al. (1982) The Action Research Planner. 2nd Edn. Geelong, Victoria: Deakin University Press.

Stenhouse, L. (1971) The Humanities Curriculum Project: The rationale. Theory into practice, X, (3), June.

Taba, H. and Noel, E. (1957) Action Research: A Case Study. Washington: Association for Supervision and Curriculum Development NEA.