NATIONAL OPEN UNIVERSITY OF NIGERIA

SCHOOL OF EDUCATION

COURSE CODE: EDU 323

COURSE TITLE: BASIC RESEARCH METHODS IN EDUCATION

COURSE DEVELOPMENT

EDU 323

BASIC RESEARCH METHODS IN EDUCATION

COURSE GUIDE

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EDU323/623 EDUCATIONAL RESEARCH METHODS

1.0   INTRODUCTION

This course, EDU323: Basic Research Methods in Education is designed to give you self instruction on the rudiments of educational research practices and statistical methods. It teaches you how to understand the research problem, how to select the research problem, the investigations, data collection methods, analysis, interpretations and how to present the report. It is comprehensive to help you carry out your project in research without any encumbrances. The statistical tools which you will need to present and analyse your research data have been presented in a very systematic manner so that you can use them with less difficulties. The various data collection techniques have been explained. With this you can carry out any research project with ease.

2.0   COURSE AIMS

The aim of this course is to acquaint you with the basics of research methods and statistics used in educational research processes. It also aims at encouraging you to learn the nature, concepts, steps and procedures for carrying out your research project or any other research study.

3.0   COURSE OBJECTIVES

By the end of this course, you should be able to:

(i)   Explain the concepts and processes of educational research;
(ii)   Discuss the different types of research;
(iii)   Identify researchable problems in education;
(iv)   Demonstrate skills in literature review;
(v)   Formulate research questions and hypotheses;
(vi)   Explain the different types of research designs;
(vii)   Differentiate between population and samples;
(viii)   Apply the different methods of data collection;
(ix)   Compare the different methods of data collection;
(x)   Discuss the properties of a good instrument;
(xi)   Organize and present data using different methods;
(xii)   Demonstrate proficiency in the use of descriptive statistics;
(xiii)   Use inferential statistics to test hypotheses;
(xiv)   Explain the steps in testing hypotheses;
(xv)   Write reports of research projects.

4.0   WORKING THROUGH THE COURSE

This course EDU323: Basic Research Methods in Education expects you to do a lot of reading in order to cover the content in the course material. It implies that you should devote much time to this course by reading through this material and getting more information from numerous texts and journals in research. These abound in every library and from the internet. The course

material has been made easy to read and user-friendly. However, you will need to attend the tutorial sessions where your Facilitator would open your eyes to more information and the practical techniques involved. You will need to work in groups with other students in order to discuss, compare notes and thoughts and to exchange ideas and share knowledge.

5.0 COURSE MATERIALS

The National Open University of Nigeria will provide you with the following items:

- Course Guide
- Study Units
- TMA Assignment file (will be available from the web CT OLE in due course)

You are required to make use of your calculator, mathematical or drawing set, graph book and statistical tables. In addition, at the end of every unit is a list of texts for your references and for further reading. It is not compulsory for you to buy or read all of them. They are essential supplements to this course material.

6.0   STUDY UNITS

The study units in this course are as follows:

MODULE 1: RESEARCH PROCESS
Unit 1:   The Research Process I
Unit 2:   The Research Process II
Unit 3:   The Research Problem
Unit 4:   Review of literature
Unit 5:   Population and samples

MODEL 2:   RESEARCH DESIGNS
Unit 6:   Historical and Developmental Research Design
Unit 7:   Survey and Case Study Research Designs
Unit 8:   Correlational Studies
Unit 9:   Experimental Research Designs

MODULE 3: DATA COLLECTION
Unit 10:   Observation Technique
Unit 11:   Questionnaire
Unit 12:   Interview
Unit 13:   The Other Methods of Collecting Data
Unit 14:   Validity and Reliability of an Instrument

MODULE 4: STATISTICAL METHODS
Unit 15:   Introduction to Statistics
Unit 16:   Methods of Organising Data and Measures of Central Tendency
Unit 17:   Measures of Variability or Spread
Unit 18:   Measures of Association/Correlation
Unit 19:   The Testing of Hypotheses
Unit 20:   Writing Research Report

In Module 1, the first unit introduces you to the research process by explaining the meaning of research in general and educational research in particular. It also discusses the characteristics of research and purposes of educational research. Unit 2 is a continuation of research process. It discusses the steps in the research process, types of research, the scientific methods in educational research and the limitations. Unit 3 tells you how to select the research problem, the sources of these problems and the criteria for selecting the problems. In addition, background of the study, statement of the problem, purpose of the study, the scope, the research hypotheses and the research questions are discussed. Unit 4 deals with the literature review under the citations and ethical considerations in research. Unit 5 introduces you to population and sampling. Under this, you will study the population, the sample, sample size, sampling techniques and the types of samples designs.

In Module 2, Unit 1 tells you about historical research designs, the meaning, importance, limitations, procedures, sources of data and also meaning and approaches in the conduct of developmental research design; Unit 2 discusses the meaning, classification, advantages and the disadvantages of survey research. It also talks about the meaning and importance of case studies. In Unit 3, you will study the meaning, purpose, limitation, types and methods of calculating correlation coefficients. Unit 4 deals with experimental designs. You will see the meaning, basic characteristics, true and quasi-experimental designs and the differences between them.

Module 3 deals with data collection. Unit 1 explains observation, the meaning, techniques, observational variables, instruments, factors that affect observation, limitations, advantages and disadvantages. You will know more about how to appraise observational methods of data collection. Unit 2 is all about questionnaire, its meaning, types, construction of items, validation, testing, administration, advantages, disadvantages and appraisal of questionnaire method of data collection. Unit 3 will teach you all about interview, the meaning, phases, advantages, disadvantages, types, major considerations, the guidelines for conducting a good interview and appraisal of interview methods. Unit 4 deals with the uses, types and rules about tests, socio-metric techniques, inventories and necessary scales for data collection. In Unit 5, you will learn about validation of instruments. You will also learn about meaning, types and factors affecting validity and reliability.

Module 4 discusses about the statistical methods which will enable you to analyse your data after collection. In the first unit, you are introduced to the meaning, types and benefits of statistics. You will also learn about organisation and presentation of data. Unit 2 is a continuation of unit one. You will learn the method of representing data. You will also learn about the measures of central tendency i.e. the mean, the median and the mode. In Unit 3, the measures of variability or spread are discussed, while Unit 4 teaches you the different measures of association or

correlation. Prominent among these are the Pearson Product Moment, Spearman Rank Order, Point Bi-serial Correlation Coefficients. The hallmark of research studies is to test hypotheses in order to generate knowledge. Unit 5 therefore teaches you how to test your research hypotheses. The involvements, the procedures, the tests are explained.

Finally, you will need to present your research findings in a report form. Unit 6 gives you the format and steps for writing your reports.

7.0 ASSESSMENTS

There are two aspects to the assessment of the course: first are the tutor-marked assignments (TMA); and the end of course examination. Within each unit are self assessment exercises which are aimed at helping you check your assimilation as you proceed. Ensure that you attempt each of the exercises before finding out the expected answer from course material.

8.0 TUTOR-MARKED ASSIGNMENTS (TMAs)

This forms your continuous assessment and accounts for 30% of your total score. You are expected to answer at least four TMA's. These must be answered and submitted before you sit for the end of course examination. Your Facilitator will give you the TMA's and you must submit your responses to your centre.

9.0 FINAL EXAMINATION AND GRADING
The 'end of course examinations' would earn you 70% which would be added to your TMA score (30%). The time for this examination would be communicated to you.
With this examination written successfully, you have completed your course in Basic Research and one believes you would apply your knowledge (new or up-graded) in your project.

Table 1:   Course Marking Scheme

ASSESSMENT	MARKS
Assignment (TMAs) 1 – 4	Four (4) assignments, best three (3) marks of the four account at 10% each = = 10 x 3 = 30%
End of course examination	70% of overall course marks
Total	**100% of course marks**

10.0 HOW TO GET THE MOST FROM THIS COURSE

In Open and Distance Learning, the study units are specially developed and designed to replace the University Lecturer. Hence, you can work through these materials at your own pace, and at a time and place that suit you best. Visualize it as listening to a lecturer instead of reading a text. Each of the study units follows a common format. The first item is an introduction to the subject matter of the unit, and how a particular unit is integrated with the other units and the course as a whole. Next is a set of learning objectives. These objectives let you know what you should be able to do by the time you have completed the unit. You should use these objectives to guide

your study. When you have finished the unit, you must go back and check whether you have achieved the objectives. If you make a habit of doing this, you will significantly improve your chances of passing the course.

The main body of the unit guides you through the required reading from other sources. This will usually be either from your set books or from a ***Reading Section***. You will be directed when you need to use a computer and guided through the tasks you must do. The purpose of the computing work is two-fold. First, it will enhance your understanding of the material in the unit. Second, it will give you practical experiences of using programmes which you could well encounter in your work outside your studies. In any event, most of the techniques you will study are applicable on computers in normal working practice, so it is important you encounter them during your studies.

Activities are interspersed throughout the units, and answers are given at the end of the units. Working through these tests will help you to achieve the objectives of the units and prepare you for the assignments and the examinations. You should do each activity as you come to it in the study unit. There are also numerous examples given in the study units, work through these when you come to them, too.

The following is a practical strategy for working through the course. If you run into any trouble, telephone your facilitator or post the questions on the Web CT OLE's discussion board. Remember that your facilitator's job is to help you. When you need help, don't hesitate to call and ask your tutorial facilitator to provide it. In summary,

(1) Read this course guide.

(2) Organise a study schedule. Refer to the course overview for more details. Note the time you are expected to spend on each unit and how the assignments relate to the unit. Important information e.g. details of your tutorials, and the date of the first day of the semester is available from the Web CT OLE. You need to gather together all this information in one place, such as your diary or a wall calendar. Whatever method you choose to use, you should decide on and write in your own dates for working on each unit.

(3) Once you have created your own study schedule, do everything you can to stick to it. The major reason that students fail is that they get behind with their coursework. If you get into difficulties with your schedule, please let your facilitator know before it is too late to help.

(4) Turn to unit 1 and read the introduction and the objectives for the unit.

(5) Assemble the study materials. Information about what you need for a unit is given in the 'Overview' at the beginning of each unit. You will always need both the study unit you are working on and one of your set books, on your desk at the same time.

(6) Work through the unit. The content of the unit itself has been arranged to provide a sequence for you to follow. As you work through this unit, you will be instructed to read sections from your set books or other articles. Use the unit to guide your reading.

(7) Keep an eye on the Web CT OLE. Up-to-date course information will be continuously posted there.

(8) Well before the relevant due dates (about 4 weeks before the dates) access the Assignment file on the Web CT OLE and download your next required assignment. Keep in mind that you will learn a lot by doing the assignments carefully. They have been designed to help you meet the objectives of the course and, therefore, will help you pass the examination. Submit all assignments not later than the due dates.

(9) Review the objectives for each study unit and confirm that you have achieved them. If you feel unsure about any of the objectives, review the study material or consult your facilitator.

(10) When you are confident that you have achieved a unit's objectives, you can then start on the next unit. Proceed unit by unit through the course and try to pace your study so that you keep yourself on schedule.

(11) When you have submitted an assignment to your tutor for marking, do not wait for its return before starting on the next unit. Keep to your schedule. When the assignment is returned, pay particular attention to your facilitator's comments. Consult your tutor as soon as possible if you have any questions or problems.

(12) After completing the last unit, review the course and prepare yourself for the final examination. Check that you have achieved the unit objectives and the course objectives.

11.0   TUTORS AND TUTORIALS

Your Tutor or Facilitator will mark and comment on your assignments, keep a close watch on your progress and on any difficulties you might encounter as they would provide assistance to you during the course. You must mail your tutor-marked assignments to your tutor well before the due date (at least two working days are required). They will be marked by your Tutor and returned to you as soon as possible.

Do not hesitate to contact your tutor by telephone, e-mail, or discussion board if you need help. The following might be circumstances in which you would find help necessary. Contact your Facilitator if:

- You do not understand any part of the study units or the assigned readings.
- You have difficulty with the self-tests or exercises.
- You have a question or problem with an assignment or with the grading of an assignment.

You should try your possible best to attend the tutorials. This is the only chance to have face-to-face contact with your tutor and to ask questions which are answered instantly. You can raise any problem encountered in the course of your study. To gain the maximum benefit from course tutorials, prepare a question list before attending them. You will learn a lot from participations in discussions.

12.0   SUMMARY

This course EDU 323/623 is designed to give you some knowledge and skills which would help you to undertake your research project work as smoothly as possible. After going through this course successfully you would be in a good position to pass your examination at the end of the semester and apply the knowledge and skills gained in the execution of your research project. Above all, you will be able to answer such questions as can be drawn from:

The research process;
The research problem;
 Literature review;
Population and samples;
Research designs;
Data collection technique;
Statistical methods;
Research reports.

We wish you success in this practically-oriented and interesting course. We hope you will transfer what you have learnt in this course to some of your other courses that are related to this, and you will bring the knowledge from these other courses to help you perform at the optimum in understanding your research project.

We also hope you would appreciate the unique role and opportunity you have to make a difference in using the knowledge derived from this course in solving educational problems within your area of specialisation. This is the main essence of studying research as a course.

We, therefore, sincerely wish you the best as you enjoy the course. GOOD LUCK.

EDU 323; BASIC RESEARCH METHODS IN EDUCATION

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MODULE 1: RESEARCH PROCESS

Unit 1:   The Research Process I
Unit 2:   The Research Process II
Unit 3:   The Research Problem
Unit 4:   Review of literature
Unit 5:   Population and samples

UNIT 1   THE RESEARCH PROCESS 1

Table of Contents

1.0   INTRODUCTION

You may have wondered what research is all about. You may have thought about research as something exotic, not meant for the consumption of the ordinary person. You may have seen research, just like every other layman, as something which carries with it the aura of activity usually engaged in by the super-intelligent, and beyond the capability of an average intelligent person.

Are you among the people who perceive research as an activity which is undertaken with highly sophisticated equipment, and/or an activity exclusively preserved for the lecturers and 'Research Fellows' in the Universities or tertiary institutions?

In this unit, you will be presented with a de-mystifying view of research as an activity which is not far from the routine ritual of all normal thinking human being. You will see research generally as a process of finding out the answers to a problem. To this effect, you will appreciate and find it as an activity which is worth doing.

2.0   OBJECTIVES

By the end of this unit, you should be able to:

•   define research;

- define educational research;
- discuss the characteristics of research;
- explain the purposes of educational research.

3.0   MAIN CONTENT

3.1   Meaning of Research

Many writers have described research in various ways, and according to the type and the area. We can say that research is the process of arriving at dependable solutions to problems through a planned and systematic collection, analysis and interpretation of data. You may have to note that the key words in this description are **planned** and **systematic**. It means that research is considered as a logical scientific thinking. This implies that a study or an activity cannot be regarded as research unless it is carried into the higher levels of vigorous and scientific reasoning.

We can also look at research as a process of seeking answers to hypothetical questions using scientific methods of inquiry to produce valid information. It means therefore, that when you use research methods to solve problems, you are more efficient than either trial-and-error attempts or "short-run" approaches. This is because you will direct all efforts towards a particular goal based on a sound hypothetical solution.

According to Leedy (1997), research is the systematic process of collecting and analyzing information (data) in order to increase our understanding of the phenomenon with which we are concerned or interested. He goes on to say that research is not:

- mere information gathering;
- mere transformation of facts from one location to another;
- merely rummaging for information;
- a catch-word used to get information.

In their own definition, Best and Kahn (1995) agree that research is the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles or theories, resulting in prediction and possibly, ultimate control of events.

From these and other definitions, you have to note that one of the most reliable ways of ascertaining that decisions are correctly made is to use a scientific approach to arrive at those decisions. Therefore, research is needed in order to arrive at objective conclusions. Thus, the use of data to quantify statements and very assumptions with empirical evidence becomes imperative.

3.2   Educational Research

Educational research is implied when research activities are geared towards unravelling educational problems or bringing about improvement in teaching and learning. According to

Ary et. al. (1972:21), educational research is "the way in which one acquires dependable and useful information about the educative process". While Travers (1964:5) says that educational research is "an activity directed towards the development of an organised body of scientific knowledge about the events with which educators are concerned". Do you notice that the descriptions of educational research above highlight some important concepts? These concepts include: dependability of the information and its scientific nature; and the fact that the subject-matter of investigation should be of interest to educators.

Ali (1996:1) described educational research as those activities or processes which allow one to systematically test and/or obtain a body of information, data or knowledge about teaching/ learning or conditions which affect teaching and learning. This means that research in education is a systematic attempt to define and investigate pertinent problems involved in teaching and learning. This can take place within or outside the school setting. It can take place at various levels of education, such as early childhood, primary, secondary or tertiary levels. You will again note that, implicit in this definition, is that educational research employs scientific methods to find out how teaching and learning can be improved, conditions under which knowledge can be tested and verified and the conditions under which they should occur.

In his own definition, Kerlinger (1964) says that educational research is a systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relations among natural phenomenon.

Education is mainly concerned with the processes which deal with deliberate change in the behaviour of people through the acquisition of knowledge, skills, attitudes, interests and appreciation. Therefore, the goal of educational research is to discover general principles on which interpretations, predictions, explanations and control of behaviour can be based since educational research is concerned with the study of the problems of teaching and learning. It means that any research in this area should contribute to some aspect related directly or indirectly to the teaching-learning situation. Therefore, the topic selected for investigation should be truly educational, preferably a problematic topic whose findings will add to the knowledge-bank of education and to lead to some solution of a societal problem.

3.3   Characteristics of Educational Research

Earlier in this unit, we have said that mere collection of facts, whether from reference books, from readings in the library, from historical documents, from questionnaire or even from the internet, is not research, unless the information derived from the analysis of the data is used to solve problem. Based on this, let us look at some characteristics of research.

According to Anaekwe (2002), some of the characteristics are:

(i)   **Research is Systematic:** This means that the steps followed have to be sequential and logical. The procedures used can be repeated by another research to verify the findings.

(ii) **Research is Objective:** This means that the findings are reported as they are. The biases, prejudices, beliefs or interests of the researcher and/or the society are not allowed to interfere with the research procedure and/or results.

(iii) **Research Report is Precise:** This is pertinent as the use of vocabulary which is capable of multiple interpretation is not encouraged.

(iv) **Research is Testable/Measurable:** Research is not speculative, but quantifiable. It becomes imperative that data collected for research must be measurable and tested against a specified hypothesis.

(v) **Research is Replicable/Verifiable:** Results or findings of a research can be verified by the researcher or any other person interested in the findings. This can be done by going through the data used in the study or the processes involved. The research can be replicated by re-administering the same instrument or similar instrument of data collection to the same subjects or similar group of subjects. This replication can help one to justify the authenticity or otherwise of an earlier conclusion.

Best and Kahn (1995) gave a summary of the characteristics of research so as to clarify its meaning. These are:

(i) Research emphasises the development of generalizations, principles or theories that will be helpful in predicting future occurrences;

(ii) Research is based upon observable experience or empirical evidence;

(iii) Research demands accurate observation and description;

(iv) Research involves gathering new data from primary or first-hand success or using existing data for a new purpose;

(v) Research is often characterized by carefully designed procedures that apply rigorous analysis;

(vi) Research requires expertise;

(vii) Research strives to be objective and logical, applying every possible test to validate the procedures employed, the data collected and the conclusions reached;

(viii) Research involves the quest for answers to unresolved problems;

(ix) Research is characterized by patient and unhurried activity;

(x) Research is carefully reported and recorded;

(xi) Research requires courage.

Self Assessment Exercise 1.1:

1. Read through the definitions of educational research in this unit and from other sources. Formulate your own definition in your own words.

2. What is the major difference between basic research and educational research?

Check the answer at the end of the unit.

3.4   Purposes of Educational Research

Have you noted that in recent times many countries of the world have shown strong concern for improving the quality and variety of education as well as access to it? For instance, the emphasis in some countries is the provision of education to adult citizens or to citizens in remote local locations i.e. a question of access to education. In some other countries, considerable interest is on diversification of educational opportunities to take care of students of a broad spectrum and interest group. This will show you that most countries quite legitimately worry and show concern about their educational processes and products. It shows the countries' desires to have a living, growing and responsive education. These concerns have led to upsurge in research efforts aimed at identifying viable alternative action among many options. This leads to the introduction of research-based recommendations designed to improve education even with insufficient resources.

You are aware that, as a result of strong concern to take education to the doorsteps of the numerous Nigerians who are remote and educationally disadvantaged, or those who have been denied access to education as a result of one obstacle, rigid policy etc. or the other and to remove all boundaries in education, the Federal Government of Nigeria established the National Open University of Nigeria (NOUN) by an Act of the National Assembly. This is one of such concerns which have evoked invocations of new curricula, new programmes, changes in actual teaching and learning processes, changes in teachers' recruitment etc. Researches in education come with the picture because educational process is a very complex and evolving one whose every facet must be carefully and systematically investigated, understood and implemented towards achieving the objectives.

You have noted that one purpose of research is the development of theories by discovering broad generalizations or principles. This is why Good et. al. (1941) described the chief purposes to which the services of research can be put to achieve in education to include to:

(i)   determine the status of phenomenon, past and preset;
(ii)   ascertain the nature, composition and process that characterize educational phenomena;
(iii)   trace growth, change and developmental history of persons and issues and objects.

According to Best (1976), when a research becomes applied research, it can take on the purpose of improving a product or a process of production. It means that it involves the testing of theoretical concepts in actual problem-situations in industrial settings. In the field of education, it is interesting to recognise that most educational research is applied research because it attempts

to develop generalizations about the teaching-learning processes and instructional materials. Kerlinger (1971) has summarised educational research purposes as concerned with the development and testing of how students behave in the educational setting.

You have seen that research, in general, is of immense importance in all-human endeavours. This is why Anaekwe (2002) believes that educational researches have the following purposes:

(i)   to provide training in problem-solving. This is because research involves problem-solving, and life in itself is full of problems. Therefore, knowledge of research provides training in problem-solving;

(ii)   to provide valid and dependable information, which could be very useful in advancing the course of educational theories and practices;

(iii)   to evaluate educational programmes, activities, practices, resources and methods of teaching;

(iv)   to provide training in understanding of the intricacies and technicalities requisite for handling research problems in particular and problems in general.

According to Ikekhua and Yesufu (1995), the four-fold purposes of educational research are:

(i)   to provide objective evidence to improve school learning;

(ii)   to controvert myths surrounding certain practices and principles in education;

(iii)   to change beliefs characterizing practitioners and products of education and the consumers of the products of education, and

(iv)   to help place the work of the school and its agents on a firmer ground with consumers of education.

You will notice that from the foregoing and from Ali (1996), it is apparent that research has, as its role in the educational process, several purposes. It provides the hard data and information which give a clear picture, the true picture, the objective picture about how we teach and learn as well as what we are doing about schools and schooling. When such a picture is dispassionately superimposed or interpreted against reality, comparisons of what is versus what should be and the choices we need for getting to where we want to be in the process of education become apparent. Therefore, research plays the role of giving us a rich picture of the process of education.

Self Assessment Exercise 1.2:

What are the four-fold purposes of educational research, according to Ikekhua and Yesufu (1995)?

Compare and contrast the purposes of educational researches as presented by Anakwe (2002) and Ikekhua and Yesufu (1995).

4.0   CONCLUSION

You have learnt in this unit that research is a search for solution to problems. It is a process of arriving at dependable solutions to problems through the planned and systematic collection, analysis and interpretation of data. In education, research does not mean a search that yields infallible truth but rather a search that throws new light on questions that concern educators. Because, you as an educator, will be involved as a matter of necessity in decision making, it is the organised body of scientific knowledge about the educational process that will make the most valuable contribution to decision making in education. You will also note that mere collection of facts, whether from reference books, from readings in a library, from historical documents or from questionnaires is not research, unless the information derived from the analysis of the data is used in solving problems.

5.0   SUMMARY

In this unit, you have read some of the definitions of research. Educational research has also been defined variously, but you have to remember that research in education is one which includes the fact that it is testable, verifiable, purposeful and activity-oriented. In other words, educational research can involve those activities or processes which allow one to systematically test and/or obtain a body of information, data as knowledge about teaching, learning or conditions which affect teaching and learning.

You also learnt the characteristics of research in which you noted that research is objective, precise, testable/measurable, replicable or verifiable etc. You have also seen the various purposes of educational research in this unit.

6.0   TUTOR MARKED ASSIGNMENT

(i)   Distinguish between Research and Educational Research?

(ii)   Discuss any four characteristics ofEducational Research according to Anaekwe (2002).

Answer to SAE Question 1.1

1.   Formulate your own definition in your own words.

2.   The major differences between basic research and educational research is that while basic research is general and applies to all aspects and all subjects, educational research involves all activities geared towards unravelling educational problems or bringing about improvement in teaching and learning.

Answer to SAE Question 1.2

The four-fold purposes of educational research according to Ikekhua and Yesufu (1995) are:
(i)   To provide objective evidence to improve school learning;
(ii)   To controvert myths surrounding certain practices nd principles in education;
(iii)   To change beliefs characterizing practitioners and products of education and the consumers of the product of the education;
(iv)   To help place the work of the school and its agents on a firmer ground with consumers of education.

7.0   REFERENCES AND FURTHER READINGS

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UNIT 2: THE RESEARCHER PROCESS II

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1.0   INTRODUCTION

The research process provides a description of the systematic procedure which is usually adopted during research studies. As a scientific method of investigation, educational research uses investigative methods which are consistent with the basic procedures and operating conceptions of science.

In other words, educational research process is an adoption of the basic research process which utilizes the methodology of scientific thinking and necessarily goes about its business of problem analysis in a series of stages and steps of activities. The ultimate goal of these series of activities is to search for dependable, valid and reliable answers as solutions to some defined questions or problems in the field of education.

You will note, therefore, that educational research also shares in the values of the culture of science. These stages of steps are in logical sequence with one step leading to another and are linked for one common goal.

In this unit, you will learn about the steps in the research process, the types of research and the relevance of educational research in Nigeria.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

- explain the steps in the research process;
- discuss the types of educational research;
- enumerate the limitations involved in the application of scientific method in educational research.

3.0   MAIN CONTENT

3.1   Steps in the Research Process

Educational research is taken to be applied scientific method or basic research. It implies that a researcher in education may take the underlisted steps of activities during research studies on any educational problem. These steps should not be considered strictly as the only satisfactory sequence. You, as a researcher or research worker or even your institution, may adopt some modifications of the research process. This is acceptable. Let us now look at the sequence recommended for any educational research:

(i)   **Identification of a Problem:**

This is the most difficult step in the research process. It involves the discovery and definition of educational research problem or problems within a topical area of interest in education. It has to be a problem or question which deals with issues of sufficient consequence to warrant investigation. The problem must be such that can be solved through scientific investigation. It must not be a solved problem, one whose solution is available. It must not be a question requiring 'Yes' and 'No' answers. Examples of educational problems are:

What are the causes of students' unrest in our higher institutions? Should sex education be introduced in our secondary schools? What are the patterns, causes and solutions of learning problems? What are the factors affecting students' academic achievements?

(ii)   **Review of Related Literature:**

When a problem exists, review of related literature is a step two. However, in some studies this is step one as a source of the problem. You will need to review books, journals, magazines, theses and other materials related to the problem of study, either directly or indirectly. This will help you to identify some background information about the problem of study. It will also help you to:

(a) eliminate duplication of what has been done already;
(b) guide your formulation of research hypotheses or questions;
(c) sharpen your focus of the study as well as give you insight as to whether the problem is researchable or not; and
(d) the type of problems you may encounter in the process and how to take care of them.

(iii)   **Formulating Hypotheses and/or Research Questions:**

This calls for you to present clearly and concisely the logical aspects of the problem in an attempt to sharpen your focus on the problem. It involves the conjecturing of the relationship between the concepts and variables identified in the problem.

The hypothesis serves as a tentative answer to the problem. It can be from the result of employing logical processes of deduction and induction to formulate an expectation of the outcome of the study.

(iv) **Selecting the Research Design:**

This implies the selection of the appropriate research approach for the investigation. A research design can be a specification of the operations for the testing or verification of the hypotheses under a given set of conditions and of procedures for measuring variables. It involves the selection of persons or things to be studied. Examples can be descriptive survey, experimental, quasi-experimental, factorial designs etc.

(v) **Collection of Data:**

This stage aims at collecting relevant information for measuring the selected variables and for building up a body of valid and reliable knowledge about the variables or the research topic. It involves the construction and administration of the measuring instruments. Prominent among the techniques are interviews, questionnaires, observations, tests, rating scales, documentary sources and records. You will learn more of these as we go on in this course.

(vi) **Data Analysis and Interpretations:**

Data analysis implies extracting the required information which will serve to answer the research questions or test the hypotheses from the data collected and presented earlier. The data collected must be reduced, arranged and presented in an organized form for easy analysis, using suitable statistical techniques. This will enable you to generate some research findings from which conclusions and generalizations are drawn. You can employ the help of computers and/or calculators for easy and accurate data analysis.

(vii) **Discussion of Research Findings:**

Research findings from the analysis of data are discussed to justify, interpret, explain and further the development of theories for knowledge. This discussion is done in the context and direction of the information gathered in the process of literature review. You can see that literature review is very important in this respect as it makes for very sound and balanced discussion of findings.

(viii) **Conclusions, Generalisation and Recommendations:**

At this stage, you are expected to draw conclusions from your research findings and to make generalizations of your findings as generated from your samples to the larger population.

You will have to bear in mind that the generation of valid findings, making of correct generalisation and useful recommendations for possible applications to the field of

education help to bring about progress that may be registered in the development and practice of education.

(ix)   **Writing the Research Report:**

This is the final stage of activities in the process of conducting research in education. You have the responsibility of making your procedures, findings, conclusions and recommendations available to others in an intelligible form. This involves a clear, concise presentation of the steps in the study through a research report.

Self Assessment Exercise 2.1:

What are the steps in the research process?

3.2   Types of Research

Educational research can be classified into different types. These classifications may depend on the goals, methods of investigation, kind of evidence and analysis used. These classifications are:

3.2.1   On the Basis of Goal Typology

If we classify educational researches based on the goals of the particular investigation and the use to be made of it, then we will have basic research and applied research.

(a)   **Basic Research:**

This is a type of research, otherwise called pure research which is concerned with obtaining empirical data that can be used to formulate, expand or evaluate theory. Its main aim is to extend the frontiers of knowledge with no regards to the practical application.

It investigates relationships between methods, personal characteristics, environmental variables and learning efficiency in order to develop, illustrate, test and expand theories of learning. It is not oriented in design or purpose towards the solution of practical problems. But the findings of such studies may be applied to practical problems that have social values.

(b)   **Applied Research:**

This is the application of theories and principles from basic research to solve educational problems. It is a research performed in relation to actual problems which occur in the field and under the conditions in which they are found in practice. It is aimed at solving immediate practical problems. The findings help educators to make rational practical decisions about specific problems. Applied research can be divided into three sub-categories:

(i)   Action Research:

This is undertaken by educational practitioners in order to solve their practical local problems. It is aimed at developing new skills, finding new answers or approaches to solve problems of current concern. It is practical and directly relevant to an actual life situation. It is empirical and relies on actual observation and realistic information, or data rather than subjective opinions or past experiences.

(ii)   Evaluation Research:

This is used to assess educational programmes in order to improve their efficiency by making necessary revisions or modifications. For instance, a systemic evaluation of the practice of some programmes in the school system may necessitate modifications in the requirements and policies of the education ministry. Again, the change over from one system of education to another may have been based on systemic evaluation. Example, the change from 6-5-4 to 6-3-3-4 and from 6-3-3-4 to 9-3-4 system may have been based on the evaluation research by practitioners.

(iii)   Research and Development:

According to Nkpa (1997), this is concerned with developing and testing curricula, methods and materials to ensure maximum efficiency of educational products and practices. The trial testing in schools of the curriculum materials by the former Curriculum Evaluation Study and Adaptation Course (CESAC) which is now part of the Nigerian Education Research and Development Council (NERDC) is an example.

3.2.2   On the Basis of Method of Investigation Typology

Classifying educational research based on the methods of investigation used, the following types of educational research may be distinguished:-

(a)   **Experimental Research**

In this type of research, independent variables are manipulated to observe the effects on the dependent variables. It serves to determine possible outcomes given certain conditions. There are two groups – experimental or treatment group and the control group. The experimental group receives the treatment while the control group may not receive any treatment. The difference is noted and used.

(b)   **Ex Post Facto Research**

Have you noticed a research study in which the researcher attempts to conduct experimental study in which he is not able to directly manipulate the independent variables? In fact, randomisation is not possible. The subjects may be grouped on the

basis of some naturally occurring characteristics. Such variables like sex, race, intelligence, aptitude, creativity, personality, socio-economic status, etc. cannot be directly manipulated. Sometimes, this type of research is referred to as causal comparative studies.

(c) **Descriptive Research**

This is concerned with either description and interpretation of existing relationships, attitudes, practices, processes, trends, etc. or the comparison of variables. It does not make attempts to manipulate variables. It may be divided into many categories. Prominent among them are:

(i) <u>Surveys</u>

In this type of research, a number of data-gathering psychometric tools and procedures are used. These include questionnaires, tests, checklists, rating scales, score cards, inventories, interviews, etc. The study can be used to ascertain the nature of a phenomenon from a relatively large number of cases. When you study the entire target population, the survey is called census. Most of the times, the entire population is too large to be handled. In this case, you have to use appropriate sampling technique to obtain a truly representative sample. You will learn about the sampling techniques later in this course. You have to note that representativeness of sample is critical to survey research, in order to make reliable inferences about the target population.

(ii) <u>Documentary Analysis</u>

In this type, documents and records are examined for relevant information. Official gazettes, minutes of meetings, reports of panels and blueprints can be examined. Content analysis of curriculum materials and classroom lessons can be included as documentary analysis.

(iii) <u>Case Studies</u>

You may decide to investigate a detailed account of individuals or aggregations of individual cases may be treated as units under this type of study. In other words, you may decide to study a phenomenon in one school, association, organisation, agency, one student, teacher, administrator, etc. in order to solve specific problems through in-depth study.

(d) **Historical Research**

This is a past oriented research; which involves the location, documentation, evaluation and interpretation of available evidence in order to understand past events. Understanding past events may lead you to greater understanding of present and future events. It may also prevent future pitfalls, or even suggest hypotheses which should be

used for the solution of existing problems. Its focus may be on social concerns, educational practices, educational institutions or the educators themselves. In historical research, evidence from relics, artefacts, documents, records, oral accounts etc. are usually relied on. If you are undertaking a historical research in education, then your evidence may be sought from attendance registers, certificates, report cards, inventories, manuscripts, equipment, records of newstalk, etc.

There are two main sources of research information in a historical study. These are primary source and secondary source. When evidence comes from direct source such as original documents, photographs, eye-witness accounts, it is called primary source. But when a non-observer mediates between the original evidence and the investigator as in books, research reviews, newspapers or stories by non-participants, it is called secondary source. As a researcher, you should always determine the authenticity of the evidence you use.

3.2.3   On the Basis of the Kind of Evidence and Analysis used Typology

Using this typology, research can be classified as quantitative, qualitative or multiple perspective.

(a)   **Quantitative Research:**

This type uses information or data expressed in numerical values. Most experimental studies fall under this type or category.

Data collection methods include tests of various types, experiments, questionnaire, rating scales etc. Quantitative data are analysed using either descriptive or inferential statistics.

(b)   **Qualitative Research:**

This type uses information which is verbal or non-numerical. It makes use of qualitative data yielded through interviews, observations, artifacts, documentary sources, audio and visual materials among others.

Information could be analysed using transcription, coding, historical and philosophical analysis. This can introduce elements of subjectivity in explaining, describing, collecting and even analyzing information.

(c)   **Multiple Perspective Research:**

This type uses both quantitative and qualitative approach otherwise known as eclectic, is usually more comprehensive, yielding more generalisable and holistic findings which are more rigorous than any one approach.

Self Assessment Exercise 2.2

(i)   What are the types of research based on methods of investigation?
(ii)   What are the types of research based on the types of evidence analysis used?

3.3   Scientific Methods in Educational Research: Limitations

You are aware that the underlying goal of the scientific method of thinking is rooted in the broad goal of science which is to understand natural phenomena through the following steps:

(i)   accurate description;

(ii)   explaining the specified conditions necessary to obtain the phenomenon in order to attain easy prediction of the phenomenon;

(iii)   organizing the available evidence supporting the phenomenon in order to attain an overall picture of the relationships surrounding all the components or variables relating to the phenomenon under consideration.

Research practices shape their values after scientific assumptions. The concern of research is to attempt to provide acceptable and verifiable explanations to problems or questions raised in order to explore the realities of the problems through the use of scientific method of inquiry. Educational researches employ the use of scientific method of research.

Vast quantities of empirical studies that are reliable have been accumulated in education , yet they have not attained the scientific status typical of the natural sciences. This is because they have not been able to establish generalizations equivalent to the theories of the natural sciences in scope of explanatory power or in the capacity to yield precise predictions. There are several limitations to this. These limitations are:

(i)   **Complexity of Educational Phenomenon:**

        Educational phenomena, most of the times, are complex and unpredictable, unlike those of the natural sciences. The natural scientist deals with physical laws like Charle's law, Boyle's law etc. which have relatively uncomplicated variables. But in education, you deal with human behaviour and development, both as individuals and as members of a group. In this case, numerous variables affect such phenomena independently and in interaction and make them difficult to study with ease.

(ii)   **Measurement Problems:**

        In the natural sciences, we use instruments like ruler, tape, thermometer, barometer, wind-vane, weighing balance, ammeter, galvanometer etc. which give perfect and precise measurements. But in education, you will not get any instrument which can yield as perfect and precise measurement.

(iii)   **Difficulties in Observation:**

Observation is a very important aspect of science, whether social sciences or natural/ physical sciences. But, it is more difficult and risky to have perfect observation in education, because it is more subjective and frequently involves personal interpretations of such things as: motive, values, attitudes etc. which are not open to inspection.

(iv)   **Difficulties of Control:**

Possibilities for effective control of experimental conditions are much more limited in education than in the natural sciences. This is because rigid control of the experimental conditions is possible in the laboratories in the natural sciences. But in education many variables including extraneous variables which are not known by the researcher, affect and influence the results.

(v)   **Difficulties of Replication:**

When two or more chemicals are put together in a test tube, the result of the reaction can be observed and reported objectively. This can be replicated or reproduced to get the same result anywhere in the world.

But it is very difficult to replicate an experiment, for instance, in teaching methods carried out in Nigeria, in any other part of the world. In other words, replication is very difficult to arrange in education.

(vi)   **Experimental Contamination**

The presence of the researcher or investigator can change the behaviour or affect the responses of the human subjects in educational research. This can result in the faking of behaviours which will influence the result. This can be referred to as Hawthorne effect. It does not happen in the natural sciences. If an acid is mixed with an alkali, they will form a salt, whether the experimenter is there or not is immaterial.

(vii)   **Problem of Randomisation**

It is easier to randomise non-human subjects in the laboratory than the human subjects. Randomisation may not be perfect in education due to administrative constraints and faking.

Self Assessment Exercise 2.3:

What are the limitations involved in the application of scientific methods in educational research?

4.0   CONCLUSION

In this unit, you have seen that the educational research process is an adoption of the basic research process which uses the methodology of scientific thinking and necessarily goes about its business of problem analysis and/or solving in a series of stages or steps.

The ultimate goal of these series of activities is to search for dependable, valid and reliable answers as solutions to some definite questions or problems in the educational field.

You can therefore say that educational research also shares in the values of the culture of science. All the stages and steps of educational research are in logical sequence with one step leading to another, linked for one common goal.

However, as you have seen, educational research cannot be as perfect and precise, as accurate and objective as experiments in the natural sciences due to some limitations.

5.0   SUMMARY

In this unit, you have learnt the steps in the educational research methods. These steps are:

(i)   Identification of the problem;
(ii)   Review of related literature;
(iii)   Construction of hypotheses and/or questions;
(iv)   Constructing the design;
(v)   Data collection;
(vi)   Data analysis and interpretation;
(vii)   Discussion of research findings;
(viii)   Conclusion and recommendations, and
(ix)   Writing the report.

You have also learnt that educational research can be classified in different types. These can be on the basis of goals; in which we have basic research, applied research. On the basis of method of investigation, we have: experimental, ex post facto, descriptive and historical. On the basis of kind of evidence and analysis, we have qualitative and quantitative researches.

You have learnt the limitations in applying scientific methods in educational research. These include:

(i)   complexity of educational phenomenon;
(ii)   problems of measurement;
(iii)   difficulties in observation;
(iv)   difficulties of control;
(v)   difficulties of replication;
(vi)   experimental contamination; and
(vii)   problem of randomisation.

6.0   TUTOR MARKED ASSIGNMENT

(i)   List the steps in the research process.

(ii)   What are the two types of research classified according to the kind of evidence and analysis? What is the major difference between the two types?

(iii)   Mention five limitations of applying scientific methods of inquiry in educational research.

Answer to SAE Question 2.1

The steps in the research process are:

(i)   Identification of the problem;
(ii)   Review of related literature;
(iii)   Construction of hypotheses and/or questions;
(iv)   Constructing the design;
(v)   Data collection;
(vi)   Data analysis and interpretation;
(vii)   Discussion of research findings;
(viii) Conclusion and recommendations, and
(ix)   Writing the report.

Answer to SAE Question 2.2

(i)   The types of research based on methods of investigation are:

    (a)   Experimental research
    (b)   Ex post Facto research
    (c)   Descriptive research
    (d)   Historical research.

(ii)   The types of research based on evidence and analysis used are:

    (a)   Quantitative research, and
    (b)   Qualitative research

Answer to SAE Question 2.3

The limitations in the application of scientific methods are:

(i)   Complexity of educational phenomenon;
(ii)   Measurement of problems;
(iii)   Observation difficulties;
(iv)   Control difficulties;
(v)   Replication difficulties;
(vi)   Experimental contamination; and
(vii)   Randomisation problems.

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UNIT 3 THE RESEARCH PROBLEM

Table of Contents

1.0 INTRODUCTION

Research problem is the focus to which all research efforts are geared. At the root of every research, there is a problem which must be established to justify the research. You will have to design investigations to find solutions to the problem. This is the goal you have to accomplish. This is because it is the problem that requires attention. At this point, the question that should bother you should be hinged on what constitutes a researchable problem.

According to Nkpa (1997), a problem arises when the interplay of two or more factors result in one of three possible problematic outcomes. These are a perplexing state, an undesirable consequence, or a conflict for which the appropriate course of action is controversial. In order to find the problem, solution, classification of the perplexing state, elimination or alleviation of the undesirable consequence, or resolution of the conflicts can then be made.

In this unit, you will read about the problem selection, sources of the problems, criteria for problem selection, delimitation of the problem, etc.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

- select a research problem in your area of interest;
- outline the various sources of research problems;
- enumerate the criteria for selecting a problem for research;

- explain the background of the study;
- describe the statement of the problem;
- explain the purpose of the study;
- discuss the significance of the study;
- describe the scope of the study;
- formulate different types of research hypothesis;
- differentiate between research question and hypothesis.

3.0   MAIN CONTENT

3.1   Identification of Research Problems

As a beginning researcher, you may find it difficult to decide on what is a suitable research problem. You may spend considerable amount of time examining many research problems without being able to make up your mind on which to select. Your indecision may be due to a fear of selecting difficult problem which you cannot easily tackle. You have to note that common errors in selecting problems arise when conditions, objectives, questions, hypotheses, topics or uncomfortable feelings are mistaken for problems.

You have to distinguish between your problem area which is of interest to you and the research problem itself. Let is be clear to you that a problem area of interest is the broad area or topic, events, phenomenon which you want to study, say in education. This area of interest may be hazy, nebulous, ethnical or inconsequential at the onset. It may remain so long after you have given thoughtful and adequate consideration to it. In this case, you are advised to steer clear of the topic, even t or phenomenon.

Before you arrive at a researchable topic, there are three systematic stages of reductive deductions which are very necessary for you to take from the general problem area. These include:

(a)   locate a general problem area in your particular field of interest;
(b)   pin this problem down to a manageable size, and
(c)   state it concisely in a form that can be empirically investigated.

These steps are not as easy to take as they look. But you have to note that a good research work is a difficult thing to undertake. No easy research topic which can be effectively carried out without careful and logical planning. But if you allow your interest to be your guide and you choose a topic that personally appeals to you as a result of your previous activities and readings, you will be motivated to spend the long and difficult hours and the painstaking efforts that are necessary for the effective execution of the study.

It may interest you to note that not every investigation or study qualifies to be called a research study. You have read earlier, in this course, that educational research is aimed at solving problems in education or providing answers to questions. Therefore, if no problem exists or cannot be identified then a study in that area should not be attempted. There must be a pressing

problem or a need which requires attention. If you have a strong feeling about the need to solve this problem, it becomes easier for you to be successful in the study.

Note that a good research study should be able to make a definite contribution to knowledge. You have to know also that merely gathering the opinion of people is not necessarily research. Later in this unit, you will read about the criteria for selecting a researchable problem. Meanwhile, let us look at sources of problems

3.2   Sources of Research Problems

If you are asked how research problems are identified or located, the question may be theory for you. It becomes useful therefore to suggest the various sources through which research problems may be generated. These are:

(i)   **Personal Experience**

If you are an experienced teacher or have had a long experience in the educational practices or observing existing practices in the education system, you would have come across a number of problems, imperfections, inconsistencies, puzzles or some gaps which need to be dealt with. Through your interactions with people and facilities in your professional experience, you may have discovered areas where knowledge is lacking and answers have to be found.

(ii)   **Literature**

When you have an extensive review of literature, it provides you with some researchable problems. Textbooks, theses and dissertations, research reports in journals and educational periodicals, conference papers among others could provide some tit-bits on researchable problems or topics.

Apart from suggestions for further research available in theses and dissertations, you may encounter contradictions, inconsistencies and unsatisfactory findings in some areas of investigation. You can then carryout a study to fill in the gaps. In addition, your study could contribute to knowledge through improved methodology or modifications to existing theory.

(iii)   **Experts' Opinion**

Consultations with professionals in a particular field, educationists, research fellows, thesis advisers or supervisors, etc. could guide you in identifying your problem area. They will help you to clarify your thinking to achieve a sense of focus and to be articulate and concise in your research topic. This depends on your interest in having an originally thought out problems. It is not good to just collect previous research topic or to go and copy already written project reports from other institutions. Though this is what undergraduates do these days, it hampers and/or obstructs academic growth and upliftment.

(iv)   **Government Publications**

Most of the times, some government policies, intentions or views on education can be published through whitepapers, gazettes, newspapers, newsletters or through the radio and television or even though circulars.

Research topics could emanate in response to a government identified problems. Such studies may focus on evaluation of existing educational programmes like, the Universal Basic Education (UBE), the 9-3-4 system of education, the factors of 6-3-3-4 system of education etc.

(v)   **Internet Sources**

These days what is in vogue is electronic learning in which people study by entering into any library in any part of the world to get current and updated information on any field including education.

Through the internet you can avail yourself the opportunity of getting current research findings or write-ups on any area of interest. You can see different methods of solving the same problem you have and you can apply such methods in your own situation.

(vi)   **Innovative and Technological Changes**

These are lots of innovations and changes especially in the use of information and communication technologies (ICT) in education. Such concepts as e-learning, m-learning, e-business, e-government, e-commerce, computer-assisted instruction (CAI), computer-base training (CBT), and conferencing among others can be investigated to determine their effects, effectiveness, implementability in our situation.

An appraisal of such teaching strategies like group-self-evaluation, cooperative learning, team teaching, mixed ability grouping, vertical and/or horizontal teaching etc. could yield researchable topics.

(vii)   **General Education Problems**

You have noticed that in Nigeria and many other developing countries, there are so many general problems facing education. These educational problems can be narrowed down to obtain a specific educational problem which you can handle effectively.

(viii)   **Replication**

Replication or repetition of an earlier study encountered in the literature review can help to increase the generalisability and validity of the findings. The replication can be done using different geographical contexts, different subjects, different levels, different time periods, different methodology or different instruments.

(ix)   **Theory**

Theories are statements put forward to explain phenomena, events or situations. They propound general principles for which applicability or educational situations require research. According to Nkpa, theories are fertile sources of research problem. This is because from theories, relationships among variables can be predicted, tested and established.

Self Assessment Exercise 3.1:

What are the various sources through which research problems could be identified?

3.3   Criteria for Problem Selection

Most of the times, several potentially researchable problems abound. Your problem becomes how to select the most appropriate one for investigation at any given point in time. Most beginning researchers have faced this difficult situation, that some of the time; they start with one problem and abandon it for another. They may attempt or make trials on several other problems before choosing one. This results in unnecessary delays in conducting the research. To avoid such pitfalls, you should be able to evaluate the research problems in order to select the most expedient, using the following criteria;-

(i)   **Significance**

You have been told earlier in this course that the ultimate goal of research is to enrich knowledge. In selecting your problem, therefore, it behoves on you to select one whose solution would make the most valuable contribution to the body of organised knowledge.

This contribution could be in the area of methodology, theory, practice or replication of existing findings to yield more reliable knowledge or to improve the generalisability of earlier findings. The contribution can be used to modify, refine or replace existing theories and relationships, in order to influence educational practice.

(ii)   **Researchability**

For a problem to be researchable, it has to involve variables which can be defined and measured. There are problems which cannot be subjected to systematized investigation. Many philosophical and ethical problems cannot be studied empirically; otherwise the findings can only yield useful information that can be used to find answers to those ethical and philosophical questions.

For instance, how can you study the influence of spiritual powers on the academic achievement of pastors? Note therefore that unresearchability is a result of unavailability of the required measuring instruments and the inability of the researcher to construct and validate novel instruments.

(iii) **Suitability**

The problem of investigation should be suitable to the peculiarities of the research. The problem is suitable if:

(a)   it is relevant to your professional goal. It should make you more knowledgeable and more proficient in your career;

(b)   it is meaningful and interesting. In which case you have to be enthusiastic enough to investigate the problem thoroughly and to persevere till the end of the research;

(c)   the solution should be within your level of competence. You have to be knowledgeable in the use of the relevant instruments; otherwise you have to acquire the expertise within reasonable time.

In other words, you have to have the relevant skills, experience, expertise and competencies and be well-acquainted with the existing theories and concepts in the area;

(d)   you should consider the availability of the required manpower, equipment, finance and other resources. Avoid problems with so many variables which only large scale studies by a team of researchers having large amounts of funding can tackle;

(e)   you should consider that the time required to get appropriate solution to the problem is realistic for your programme. There is a time limit for research undertaken for degree purposes. You have to consider this time limit in choosing the problem;

(f)   you should consider the accessibility of the respondents or subjects and the data. For instance, if you use governors, ministers or commissioners as your subjects, you have to consider how to reach them with ease.

(iv) **Viability**

A research problem should be viable. In this case, it can be expanded or followed up in further researches. It should not be a dead end. As you answer the research questions, further questions which require investigations should be generated.

Tuckman (1972) summarised these criteria in four points:

1. What is/are the relationship(s) between the two or more variables?
2. State the problem clearly and unambiguously.
3. Ensure that it is possible to collect data to solve the problem.
4. Avoid dealing with moral and ethical issues.

3.4   Background of the Study

This is the introduction to the study which usually contains a brief explanation of the concepts in the title as they relate to the study. A concise information required to understand the problem is presented here. According to Ali (1996), it provides at a glance, a concise information of the major theoretical, empirical and experimental considerations or substance upon which the work is anchored.

The background information will put the research problem into perspective. It has to be sharp and precise without an outburst of personal bias. At this stage, you have to highlight all the variables of interest in the study as well as their interplay with the research problem. You can even cite few works already done in the area which prompted your investigation in that area.

3.5   Statement of the Problem

The statement of the problem is a concise, clear and persuasive information on the subject matter of investigation as well as the variables planned for investigation. It needs to be very specific and direct.

It is presented in a logical sequence. It starts with such information required for the understanding of the problem, some justifications including citations and a declarative statement or an amplification in the form of question.

Self Assessment Exercise 3.2:

(i)   Enumerate the major criteria for problem selection in research.
(ii)   What is the statement of the problem?

3.6   Purpose of the Study

In the last section, you were told that the statement of the problem is a statement which pinpoints what is wrong with or about the subject matter of interest. But the purpose of the study provides you with an overview of the intention of the study as contained in the research title and its breakdown in specific terms. What do you intend to do?

This is presented in a clearly and unambiguous statement which must be expressed in a language couched in proposed undertaken action that is tenable, sensible and practical.

3.7   Significance of the Study

This is the rationale for the study. It explains the use or the importance of the findings and the who and how such information will be useful. It also explains how the findings would contribute in terms of extending the frontiers of knowledge, raising new questions or suggesting variations in the existing practice, or to reveal a gap which the study will close.

3.8   Scope of the Study

This gives you the extent of the content coverage which you could tackle with the available resources. It involves the delimitation of the study which specifies the boundaries to be covered in the study.

3.9   The Research Hypothesis

The word 'hypothesis' is a combination of two words – hypo and thesis. Hypo means "less than". Hypothesis means therefore "less than a thesis". While a thesis is a proposition to be proved or defended, a hypothesis can be referred to as a reasonable guess or thesis which although derived from some sort of evidence is yet to be tested or proved. It is a statement which gives an insight of what you expect to be the outcome of your study regarding the variables contained and investigated in the statement of the problem.

In other words, the hypothesis is in itself an explanation for certain observed or observable events, behaviours, phenomena or predictions with regards to how they occur, why they occur or when they occur. These expectations and explanations must be clear, succinct, testable and verifiable. The aim of a hypothesis is not to prove anything, but to test whether it should be accepted or rejected. This is done with data rigorously and painstakingly collected through empirical research.

According to Tuckman (1972), there are three characteristics of a good hypothesis. These are:

(i)   It should conjecture upon a relationship between two or more variables;
(ii)   It should be stated clearly and unambiguously in the form of a declarative sentence;
(iii)   It should be testable.

Hypothesis can be classified as scientific or statistical. A scientific hypothesis is a suggested solution to a problem. It is an intelligent, informed and educated guess. While statistical hypothesis is a statement about an unknown parameter. For a hypothesis to be useful, it must be both scientific and statistical.

Hypothesis can also be classified as either inductive or deductive. Any hypothesis stated based on mere observation, not based on any verifiable data or evidence, but used for predictions is an inductive hypothesis. But any hypothesis that is testable based on collection and analysis of relevant data to support or reject, is deductive.

There are two types of deductive hypothesis used in empirical or scientific research. These are the alternative hypothesis H_a or H_1 and the null hypothesis H_0. The alternative hypothesis states that there is a statistically significant difference or relationship between two variables, two individuals or two events, $(x =/ y)$. This can be directional or one-tailed test, because it tells you the direction of the difference. For instance, x is better than y. Students who learn by practical application do better than those who learn by theoretical lessons. Trained teachers teach better than untrained ones. The alternative hypothesis can also be non-directional or two-tailed test of significance. This indicates that there is a statistically significant difference, but does not show the direction of the difference. For instance, A and B are not equal; there is a statistically

significant difference in the performance of students in the science classes and those in the arts classes.

The null hypothesis, Ho is a no significant difference hypothesis. It states that there is no statistically significance between the two groups or variables under study. Thus $x = y$. For instance, there is no significant relationship between class size and students' performance in mathematics.

Self Assessment Exercise 3.3:

(i)   State two directional alternative hypotheses.
(ii)   Enumerate two unidirectional alternative hypotheses.
(iii)   List three null hypotheses.

3.10   The Research Questions

These are the major questions which you seek to answer through the study. They provide a useful basis for providing descriptive data which may then be used to get richer picture of the problem investigated.

In constructing research questions, you have to note that simplicity and clarity of language are very important. Use short, crisp and precise questions. Again, the question should seek answer to one thought or idea. It should not be double baralled. Probing questions are generally preferred. Do not overload yourself with work, so five questions and one or two hypotheses are enough workload for a typical educational research. Both research questions and hypotheses can be included in one study to serve different but complementary purposes.

Self Assessment Exercise 3.4:

Select a research title in any area of your choice in education and construct five potential research questions which could be used for the investigation.

4.0   CONCLUSION

You have seen from this unit that the selection and definition of research problem can be very difficult a task for the beginning researchers who very often catch every straw in the wind as research problem. But you have also noticed that it is possible to select and define your research problem from which statement of the problem can result.

Note that once an acceptable problem is stated, it becomes possible for you to have a clear and rich picture of what you intend to do in your study and how you can proceed to do it. This will now make it possible for you to clearly discuss and describe the scope, the purpose, the research questions, hypotheses, significance and even give the operational definition of terms in your study.

5.0   SUMMARY

In this unit, you have been presented with a practical approach towards discussing the issues about the research problem. You have seen that though it is difficult to select and define a research problem, yet if you locate a general problem area in your field of interest, you pin it down to a manageable size and state it concisely in a form that can be empirically investigated, you have solved a lot of the problems.

You have worked through the sources of research problems which include: personal experience, literature, experts' opinion, government publications, internet sources, innovative and technological changes, general education problems, replications and theories. The criteria for problem selection include: significance, researchability, suitability and genesis of further research.

In this unit also, you learnt about the background of the study, statement of the problem, purpose, significance, scope of problem, including research hypotheses and questions.

6.0   TUTOR MARKED ASSIGNMENT

1.   What are the various sources of research problems?

2.   Explain the criteria for selecting a research problem.

3.   Use two examples each to explain alternative hypothesis and null hypothesis.

Answer to SAE Question 3.1

The various sources of research problems are:

- (i)   Personal experience;
- (ii)   Literature;
- (iii)   Experts' opinion;
- (iv)   Government publications;
- (v)   Internet sources;
- (vi)   Innovative and technological changes;
- (vii)   General education problems;
- (viii) Replication;
- (ix)   Theories.

Answer to SAE Question 3.2

1.   Major criteria for problem selection in research are:

- (i)   Significance
- (ii)   Researchability
- (iii)   Suitability
- (iv)   Genesis for further research.

2. Statement of problem is a concise, clear and persuasive information on the subject matter of investigation as well as the variables planned for investigation.

Answer to SAE Question 3.3

You can state your own hypotheses.

Answer to SAE Question 3.4

You can select any title of your choice in education.

7.0 REFERENCES AND FURTHER READINGS

Ali, A. (1996). Fundamentals of Research in Education. Awka: Meks Publishers (Nigeria).

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UNIT 4   REVIEW OF LITERATURE

Table of Contents

1.0   INTRODUCTION

In the last unit, you worked through identification of problem in educational research. You learnt that a researcher is interested in seeking for the relationships between two or more variables.

These selected relevant variables are fully examined through a thorough review of related literature. This forms the basis for the investigative process. This is because it provides you with the opportunity to look into the pool of knowledge available to you.

It is the most important aspect of planning and carrying out research in education. It provides much of the theoretical reference point or basis for undertaking a proposed study.

In this unit, you will be looking at the concept of literature review, the purpose and value, sources, steps, skills, citations and ethical considerations in the review of literature.

2.0   OBJECTIVES

After working through this unit, you should be able to:

- explain the meaning of literature review;
- outline and discuss the purposes of literature review;
- enumerate the steps in reviewing related literature;
- demonstrate some skills in citations and referencing;
- list the ethnical considerations in reviewing the literature.

3.0 MAIN CONTENT

3.1 The Concept of Literature Review

From the introduction, you have noted that no meaningful research can be conducted without a thorough literature review. It is very important therefore for you to understand what is meant by the review of literature. According to Nkpa (1997), literature review is the systematic study of all existing work that are relevant to the research work. It is concerned with locating, reading, evaluating and citing reports of related research.

In his own definition, Ali (1996) described literature review as the careful and systematic identification and or location, documentation, analysis and reporting of information which are relevant, related and useful to the present study. In other words, it means making an extensive searching, reading and assessment of all available materials written and related to the problem of investigation. It could also involve some consultations with colleagues, lecturers, supervisors, known experts in the area of study as well as the library and internet sources so as to identify sources from which review information can be obtained.

Though this exercise can be tedious with some students, yet if you do it carefully and systematically, it can in fact be one of the most challenging and interesting aspects of any investigation.

3.2 Purpose and Value of Literature Review

You have already noticed that the review of related literature is very important. This is because according to Nisbet and Entwistle (1979) and Nwana (1981), so much has been discovered by scholars all over the world that almost every answer is available already in the literature. Therefore, all you need to do is to patiently consult the literature of past works which are related to your work in order to gain knowledge of how someone or some people had solved such type of problem you are saddled to study at the moment. Literature review serves the following purposes in research:

1.   It can reveal to you sources of data that you may not have known about their existence;

2.   It can describe methods of dealing with problem situations that may be similar to your own;

3.   It can reveal to you how other researchers have handled methodological and design issues similar to yours;

4.   It can introduce you to important research personalities whose works and findings you may not have come across;

5.   It can help you to evaluate your own research efforts comparing your work with similar efforts of others;
6.   It can provide you with new ideas and approaches that may not have occurred to you;

7.   It can increase your confidence in selected topic if you find that others have interest in the topic or have found value in investing time, effort and resources into its study;

8.   It can help you determine the sampling strategies that should be used in order to avoid sampling problems encountered by other researchers.

Olaitan and Nwoke (1988) summarised these purposes as:

(i)   uncover, discover and evaluate information;

(ii)   establish new relationships by analyzing and synthesizing established evidence or discovering new ones;

(iii)   replace an existing concept or completely create a new concept in an attempt to translate them into practical use;

(iv)   verify existing concepts by re-examining the premises on which the concepts were created.

Tuckman (1978) also summarised the purposes saying that Literature review uncovers;-

1.   ideas about variables that have been proven important and unimportant in a given field of study;

2.   information about work that had already been done and which can be meaningfully extended or applied;

3.   the status of work in a field in terms of conclusion and application;

4.   meanings and relationships between variables that a researcher has chosen to study and wish to hypothesise about.

Self Assessment Exercise 4.1:

1.   What is literature review?
2.   Summarise the purposes of literature review according to Tuckman (1978).

3.3   Steps in Reviewing Related Literature

Over the years, the library has been the stock house for encyclopaedia, dictionaries, textbooks, journals and periodicals, magazines and newspapers, projects, theses or dissertations. It has been a repository of writings, books and manuscripts. It has also been a kind of literary museum for books and manuscripts. If you have been to a big library like the National or State Libraries or even University Libraries and Company Libraries, the British Council Libraries, you would see that the ability to use the library is an indispensable asset to effective review of literature.

However, with the explosion of information and/or of knowledge, ideas in every human interest have been altered as a result of research findings and applications of information and communication technology (ICT).

Since libraries can no longer hold all the required information and again since the users of libraries have become more sophisticated in their wants and desires for knowledge and since ease and speed of access to information are very important priorities in library search, two types of libraries have evolved. These are the physical libraries and the e-libraries.

The e-libraries or virtual libraries provide new ways of storing and accessing vast amount of information from any part of the world. The use of computer, CD-ROMs, floppy disc, flash drive, etc. are fast replacing and supplementing the shelves of texts and periodicals.

In other words, with the computer, you can access any type of vast amounts of information, countless online data bases and manipulated factual information with increased accuracy, efficiency and little or no time.

A summary of the steps you can use in conducting your literature review are as follows:

(i)   Identify, select and list the key words or concepts which are associated with the topic of investigation.

(ii)   Use the selected key words or concepts to access relevant references from such preliminary sources of information as the catalogue, the index and dissertation abstracts or computerized referencing services.

(iii)   When you have obtained the list of useful references you can now consult libraries and other information depositories in order to access references materials. You can also make use of the internet to access the materials.

(iv)   Before you start reading, you should be able to get index cards on which to record the information, prepare a note card or index card for each reference material consulted, such that at the end you arrange them sequentially according to subheadings in the literature review.

(v)   Read the reference materials and as you read make brief notes and pay attention to the problem, procedure, design, result or just the summary for theoretical opinions.

(vi)   For quick identification, each entry on an index card should be clearly coded at the top using the key words for the broad topic. After this, the author's names and date of publication come next, followed by the title of the work and the full citation of the work and the ideas which you find useful.

(vii)   In writing out the references in the index cards, you have to choose a referencing style and be consistent with it. You will learn more on this in the section on citation.

(viii)   Ensure that you review or dwell more on the primary sources of information than the secondary sources. This will enhance the authenticity of your work, and provide you with comprehensive, unadulterated and un-mutilated first hand information.

(ix)   Consult the most recent references first. This will help you to save time, get the most recent materials and avoid redundant and unnecessary materials.

(x)   You will save a lot of time by first reading through the abstract and/or summary of any referenced material. This will enable you to quickly ascertain the relevance of the materials.

(xi)   Lastly, organise and write-up all the insights you received while reading. This should be a critical appraisal of the state of the art in the area of investigation. You have to ensure that you understand all the related issues. The ideas must flow in accordance with the trend of thought.

Self Assessment Exercise 4.2:

Identify any topic of your choice in any area of your choice in education. Do a literature review on the topic following the steps above.

3.4   Citations

Whenever you lift any idea or ideas from any referenced materials, you must duly acknowledge the source. This includes verbatim quotations, paraphrased statements, diagrams, tables etc. You have to note that careless statements from newspapers and magazines are not appropriate in research. Sources can be cited in the text in various ways, while full bibliographical details of the reference materials are listed at the end of the write-up. You will see some examples later. Different formats for preparing references are available.

In educational research reports, the style used is in line withy most psychological journals such as the journal of educational psychology, the journal of the APA – American Psychological Association, the British or Turabean style etc. But most universities in Nigeria prefer and use the APA style.

3.4.1 Examples

Some of the examples are as follows:

(i)   For a paraphrase; the source can be cited in either of three ways. These are:

(a)   in the middle of the sentence e.g. the National Open University of Nigeria (NOUN), like most tertiary institutions in Nigeria, according to Okonkwo and Osuji (2003), makes use of the two modes of assessment for her students;

(b)   at the end of the sentence e.g. our educational system needs a radical departure from the conventional face-to-face system to the unorthodox open and distance learning system (Osuji and Salawu, 2006);

(c)   at the beginning of the sentence e.g. Nkpa (1992) confirms that derived scores have been shown to be more useful than raw scores in the identification of students' potentials.

(ii)   For Quotations; if the quotation is verbatim, it is enclosed in a double inverted commas or quotation marks. You have to insert the source with the page number from where the statement is lifted e.g.

According to Osuji (2006:71), "The simplest but crude and unreliable method of estimating variability which is usually affected by the presence of two extreme scores is the range"

<div align="center">or</div>

"Derived scores are more useful than raw scores for identifying the potentials of students" (Nkpa, 1992:54)

<div align="center">or</div>

Nwana (1979:23) said that "Measurement were not absolutely dependable, however, otherwise all ten results would have been exactly the same".

You have to bear in mind that quotations longer than three typewritten lines or more than 40 words should be indented. There will be no quotation marks, but the page is indicated after the year of publication.

You will have to note that verbatim quotations must contain the exact words, spellings, capitalization and interior punctuations of the original source. If you have to effect any change like underlining or italicizing of words for emphasis, you have to enclose the words "italics added" in brackets immediately after the underlined or italicized words.

Similarly, if you insert any remarks into quoted material, you should enclose it in square brackets. Again, if you have to omit any word or words from a quotation, you have to indicate the omission by using three dots (…). This can even be used more than once in a quoted material to indicate all missing parts.

If you want to make reference to more than one publication of an author for the same year, you have to use the letters (a, b, c, d etc) to distinguish between the different works e.g. Osuji, 2006a; Osuji, 2006b; Osuji, 2006c. If you are going to cite two or more publications in the same parenthesis, they should be arranged chronologically e.g. Jegede (2001, 2003, 2005, 2006) or Otto-Peters, 1980; Okeke, 1984, Jegede, 2001, Alaezi, 2005 and Koul, 2006.

When you want to cite joint authors, both names should be cited each time the publication is cited in the text, where you have only two authors e.g. Okonkwo and Osuji (2003). But where

you have more than two, but less than six authors, all the authors are cited in the first time the publication appears in the text, subsequently, you can cite only the first author followed by "et. al" e.g. Osuji, Salawu, and Aiyedun (2006:15) … subsequently, it becomes Osuji et. al. (2006:15).

Where the authors are a corporate body, you have to give the name of the body in full in the first instance. Subsequently, citations of the publication will bear the abbreviated name e.g. National Open University of Nigeria (2003) can be abbreviated to NOUN (2003). National Educational Research and Development Council (1989) can be NERDC (1989). Abia State University (2000) can be ABSU (2000). Indira Gandhi National Open University (2005) can be IGNOU (2005).

On the reference page, all works cited in the texts or consulted should be shown arranged in alphabetical order. For unpublished theses/dissertations, e.g. Osuji, U.S.A. (2002). The Effect of Group-Self-Evaluation on Learning Outcomes. *Unpublished Masters Dissertation*. Uturu: Abia State University Library. You will have to read some research textbooks to get more examples.

Self Assessment Exercise 4.3:

Get some research or academic journals. Check the citations critically. List ten (10) different citations and examine their conformity to the A.P.A.model.

Some of the times, you have to use the internet to source for your materials. These days, every research problem or topic or words or variables can be located with ease and showing different types of findings and write ups on them. When you use any of such materials, you have to cite them e.g. Koul (2005): Current research findings (on-line) http://www.nounonline.com/noumgt or Osuji and Adeoye (2006). Effective supervision and assessment of teaching practice (on-line) http://www.nou.edu.ng. sourced 15 oct.2009.

Self Assessment Exercise 4.4:

Use your internet facilities and locate five articles in educational evaluation. Write down the URL address.

3.5   Ethical Considerations in Research

You are aware that educational research is a systematic study which makes use of scientific approaches and methods in problem solving situations. It implies that scientific attitudes should be brought to bear in carrying out such activities like the research process. Can you recollect some of the scientific attitudes you have learnt during your primary science. These attitudes which should be applied in the research process include:

• **Openness:-** especially in the areas of data collection, treatment of findings and literature review.

• **Honesty:-** especially in the areas of data collection, treatment and interpretation.

- **Humility:-** especially in the areas of validation of instrument.

- **Objectivity:-** especially in drawing conclusions from the research findings.

You are cautioned, at this moment, that you have to adhere strictly to the rules of the game in order to minimize ethical issues which are often encountered in the conduct of the research studies. According to Anaekwe (2002), such ethical issues include:

1. Plagiarism

This refers to copying someone's work without acknowledging him as the source of such information. In the academic circle, it is a very serious offence which can lead to litigation, denial of the award of degree or certificate, termination of appointment among others. Therefore, in order to apply your attitude of openness and scientific honesty, you must acknowledge all authors consulted.

2. Arm-chair Researching

This refers to people staying on their tables and manipulating figures and building up a theoretical framework, and later publishing the concoction as an empirical study. These days, students are used to coping or photocoping previous research works from other institutions and submit same in their own name, in their own institution. This is against the ethics of the research enterprise.

According to Anaekwe (2002), it negates the purpose of research and kills initiatives and intellectual growth in research business. DO NOT INDULGE IN SUCH MAL-PRACTICES.

3. Faking

Fakability involves the documentation of false information or sources of information. As a researcher, you should endeavour to present authentic sources of information used in the study. This will enhance the content validity of your work as well as the replication of the work and the retrieval of such source materials by subsequent researchers.

4. Over-citation of a particular Author

Some students often over-cite the works of their supervisors and/or lecturers. This is not very good as it limits the research to a microcosm of available information. Avoid it.

Self Assessment Exercise 4.5:

(i)   What are the scientific attitudes applicable to research?

(ii)   What are the ethical issues involved in research?

4.0   CONCLUSION

In this unit, you have learnt that literature review is the systematic search for and documentation of information useful and relevant for investigating a proposed research problem. It means that any review carried out should serve certain clearly defined purposes.

Any approach to literature review must follow certain guidelines. These involve locating and using a variety of reference sources. But in so doing, you have to consider certain issues which are related before undertaking a comprehensive and high quality literature review. These issues have been discussed.

5.0   SUMMARY

In this unit, you have worked through the concept of literature in which you learnt that literature review is the careful systematic identification and/or location, documentation, analysis and reporting of information, which are relevant, related and useful to the present study.

You have seen the purposes of literature review as summarised by different authors. The steps in reviewing literature have been presented in the unit too. Different ways of citations have been also been presented. Again, some ethical considerations have been discussed. Read more from your reference materials.

6.0   TUTOR MARKED ASSIGNMENT

(a)   (i)   What is literature review?
       (ii)   List the purposes of literature review as summarised by Tuckman (1978).
       (iii)   Outline the scientific attitudes applicable to research and the ethical issues in research.

(b)   Take any textbook or journal of your choice and list ten (10) references cited.

Answer to SAE Question 4.1

(i)   Literature review is the careful and systematic identification and/or location, documentation, analysis and reporting of information which are relevant, related and useful to the particular study.

(ii)   According to Tuckman (1978), the purposes of literature are:

       (a)   Ideas about variables that have proven important and unimportant in a given field of study;
       (b)   Information about work that has already been done and which can be meaningfully extended or applied;
       (c)   The status of work in a field in terms of conclusion and application;

(d)   Meanings and relationships between variables that a researcher has chosen to study and wish to hypothesis about; these are uncovered through literature review.

Answer to SAE Question 4.2

You can do that on your own.

Answer to SAE Question 4.3

You can do that on your own.

Answer to SAE Question 4.4

You can do that on your own.

Answer to SAE Question 4.5

(i)   The scientific attitudes are:

    (a)   Openness
    (b)   Honesty
    (c)   Humility
    (d)   Objectivity

(ii)   The ethical issues are:
    (a)   Plagiarism
    (b)   Arm-chair Researching
    (c)   Fakability
    (d)   Over-citation of a particular author.

7.0   REFERENCES AND FURTHER READINGS

Ali, A. (1996). Fundamentals of Research in Education. Awka: Meks Publishers (Nigeria).

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UNIT 5   POPULATION AND SAMPLES

Table of Contents

1.0   INTRODUCTION

You have been told that one purpose of research is to discover new knowledge that can be generalised to a defined group.

According to Ali (1996), a central and sustainable premise upon which scientific research is based is the investigation of a problem using a small representational and proportionate group that is observed and from whom findings made are generalised to all others who were not investigated.

Generalisability of research findings is dependent, as much as possible, on the extent to which the population of the study is defined and on the adequacy of the sampling procedure used in the in the study. Since these concepts – population and sample are of fundamental importance to research, we shall discuss them in this unit in relation to education so that you will understand what they mean and also appreciate their importance.

2.0 OBJECTIVES

After working through this unit, you should be able to:

- define population and sample;
- explain the sample size;
- differentiate between probability and non-probability sampling techniques.
- discuss the sampling techniques.

3.0 MAIN CONTENT

3.1 Population

This concept population, most of the times, is used to describe the total number of people living in a defined geographical entity or area. This is as it relates to the common usage of the term population. But in research, population is not limited to human beings alone, it includes objects, events, people that have at least a common characteristic which is common to all of them.

According to Nkpa (1997), a population refers to all the elements in a well-defined collection or set of values. Kerlinger (1981) defined population as all members of any well-defined class of people, events or objects. It means therefore that any entity, group or set which constitutes a population must have at least one attribute or characteristic which is common to all of them.

The population of a study therefore represents the target of the study as defined by the aims and objectives of the study. When you conduct a research study, you have a particular population in mind. For instance, chemistry teachers in the unity school, technical drawing teachers in Imo State Senior Secondary Three students offering physics in the 2007 school certificate examination from Lagos State, women farmers in Etiti agricultural zone, Professors in Nigerian Universities etc.

A research is expected to yield findings which can be applicable to the entire universe, a section of the universe, or certain elements in the universe. For instance, a research which aims at using an instructional strategy to teach Igbo Language (L_2) to non-Igbo speakers of Junior Secondary Two at Federal Government College, Okigwe, may have the findings applying only to a target population which comprise the non-Igbo speakers in F.G.C. Okigwe. In other words, the findings are expected to be generalised only to non-Igbo speakers in JS. II of F.G.C. Okigwe.

It means therefore that the population to which a researcher intends to generalise his or her findings is known as the target population. If the generalization is to the non-Igbo speakers in JS II of all the unity schools in Nigeria, then non-Igbo speakers in JS II from the unity schools in Nigeria form the target population.

3.1.1 When to Study the entire Population

You would have noticed that whenever the term population is mentioned in common usage, it often implies a huge number of people. But in research, the term represents numbers which may

range from very few to very many people, things, objects, events etc. depending on the nature of investigation to be carried out. You have also noticed that in most studies, samples are drawn and studied with a view to generalizing the findings to the entire population. However, some of the times, it is necessary to study the entire population. This is possible under the following conditions:

(i)   When the research involves a population of very few subjects. If the study involves a population of relatively few people, institutions, objects, events or things. It is better to study the entire population. Again, if members of the population are few and hold views or characteristics that should not be neglected, or when sampling cannot be representative of the population, then the entire population is studied.

(ii)   When enough time and resources are available the entire population can be studied. When there is enough time and fund the entire population can be studied.

(iii)   When the research specifically seeks to determine the population-, in some situations there is a need to determine the precise number of subjects belonging to categorized set of characteristics.

(iv)   When the topic demands the study of a specific group,- sometimes such group can be distinguished from any other group or persons e.g. the classification of prisoners at the Okigwe Prisons by gender and geopolitical zones.

Self Assessment Exercise 5.1:

1.   Give ten examples of a target population that can be used for research purposes in education.

2.   Give five examples of situations where the entire population can be studied.

3.2   Sample

From Section 3.1.1, you learnt that certain kinds of research can be carried out using the entire population. When you study an entire population, you are more able to generalise your findings to that population. Most of the times, the target population is too large for a researcher to study. The number of subjects may be too many for the researcher to handle with limited resources available. The geographical spread or area may be two wide to cover with the limited time for the research. As a result of cost, time and other constraints, it may be very difficult to study the entire population.

It becomes necessary, reasonable and only feasible to study a portion of the population which is described as sample. It means therefore that the portions of populations that are studied on the bases of which conclusions are made on the entire populations are called samples. These samples represent populations, so we can have samples of people, objects, institutions and things. For instance, a researcher who wants to study local government administration of primary education in Nigeria may decide to take 100 out of 774 local government areas in

Nigeria for the study. If your study is on mathematics teachers in Imo State, you can only sample a number of them. It is not possible for you to study all education students from federal universities in Nigeria. You can only take samples.

For the purpose of your research projects, you are constrained to limit your investigations to smaller controllable samples. To this effect, you may be faced with a very crucial decision to make. That is, how to select samples that will truly represent the population to which the findings would be generalised.

If the sample does not truly represent the population, inferences drawn or decisions taken about the population characteristics from such sample cannot be valid, no matter how powerful the statistical techniques used. Therefore, no new knowledge would be generated and efforts and resources would have been wasted.

3.3   Sample Size

Once you have identified your target population and its characteristics, two major issues may be required to be taken care of. These are how to compose the samples and the sample size. The composition of the samples will be treated in the next section.

On the issue of determining a sample size, which would adequately and appropriately represent the population it would be drawn from, you will note that a large sample size increases the likelihood of accurately estimating the population characteristics from the sample. You should, therefore, select a sample which is large enough to improve the possibility of getting results which may be similar to what you would have obtained if you had used the entire population. There is no single number which has been fixed as an ideal sample size.

The sample size is dependent on a number of factors. According to Ali (1996), such factors include:

- expense in terms of time and money;
- subjects availability to participate in the study;
- size of the population of the study;
- management and control abilities of the researcher;
- complexity of the research conditions and that of the data to be collected and analysed;
- efficiency in drawing the sample itself;
- level of cooperation expected of and available from the proposed sample/

However, a large sample is much more likely to be representative of the population.

Self Assessment Exercise 5.2:

(i)   Differentiate between population and sample.
(ii)   What are the factors which affect sample sizes?

3.4   Sampling Techniques

Sampling techniques are simply defined as methods of drawing samples from total populations. These methods are classified into probability sampling and non-probability sampling;

3.4.1   Probability Sampling

A probability sampling is one in which chance factors determine which elements from the population will be included in the sample. It is therefore theoretically possible to calculate the probability that any specific element in the population would be included in the sample. In practice, probability sampling techniques are known to generate valid samples that are truly representative of their large populations. This is because of the principle that gives all the individual subjects of the larger population equal opportunities of being selected and included as members of the drawn samples. The probability sampling techniques include: simple random sampling, systematic sampling, stratified sampling, cluster sampling, etc.

3.4.2   Non-Probability Sampling

These are samples for which the probability of a member of the population being selected cannot be calculated. According to Nkpa (1997), statistical inferences cannot be used to legitimately to generalise statistically from a non-probability sample to the target population. Generalisation from non-probability sample can only be made by satisfactorily replicating the investigation in several contents. The non-probability sampling techniques are known to generate biased samples which are not truly representative of the total population. The techniques include: purposive sampling, volunteer sampling, quota sampling, captive sampling, accidental sampling, availability sampling etc.

3.5   Probability Sampling Techniques

This section will describe the different types of probability sampling techniques.

3.5.1   Simple Random Sampling

A critical feature of this sampling technique is that each member or element of the defined or target population has an equal probability or chance or opportunity of being selected, and that the selection of each case, member or element from the population is independent of the selection of another. By independence, in this case, we mean that the selection of one member or element or case does not in any way affect the selection of any other member of the population.

The main purpose of using random sampling techniques is to select a sample which is representative of the population and which can yield data that can be used for generalisation to a larger population.

The simple random sampling requirements of independence and equal probability are met by the use of a variety of methods. These are;-

(a)   **Balloting or Hat and Draw method**

This is otherwise called the lottery method in which all the subjects in the population are listed or numbered in cards or papers. These papers are shuffled and re-shuffled. These cards are then drawn from the container one by one, with or without replacement. Any number picked up forms part of the sample.

(b)   **Table of Random Numbers**

This is a more systematic, refined and scientifically generated random numbers. It is a continuous sequence of numbers which do not appear in any particular order and which is generated by computers. In recent times, many table of random numbers have been generated by computers. These include Snedecor and Cochran's (1969), Ten Thousand Random Numbers; The Million Random Digits with 100,000 Normal Deviates by Rand Corporation (1965), Table of 105,000 Random Decimal Digits by the Interstate Commerce Commission (1979) etc. Some statistical textbooks contain table of random numbers in their appendices.

To use the table of random numbers, you have to number the population serially from one to the last person, event, object, case of element. You can then, at random, select a number from any page or point, row or column and draw your sample using the first two, three or four digits or you can use the last two, three or four digits. During the process of drawing your samples, if a number appears twice, or a number is larger than the population size, you have to ignore such numbers and continue until your sample size is composed.

The limitation in the use of simple random sampling is that, it can only be used with small population, since you have to enumerate or number all the subjects in the population.

3.5.2   Systematic Sampling

This involves, first listing in a serial order, all the events, persons, objects or things in the whole population. After this, the population (N) is divided by the sample size (n) to get the Kth interval. Once the Kth case is decided, all others are automatically selected. For instance, assuming you have a population of 1,000 people and your sample size is 100. Then Kth position will be given by $N/n = 1000/100 = 10$. It means that every 10th position or interval is automatically selected as part of the sample.

Thus, numbers 10, 20, 30, 40, etc. are already selected. You can even select any number: 1, 2, 3, …. 10 as the Kth number. For example, if the Kth case is 5, then 5, 15, 25, 35, 35 etc. become members of the sample.

You would have noticed that independence is not ensured in systematic sampling. This is because, once the first member – Kth is selected, every other member of the sample is automatically determined. This is a limitation in the use of this method.

3.5.3   Cluster Sampling

When the population of the study is very large and widely dispersed or spread, it poses administrative problems to use simple random sampling. For instance, a population composing all junior secondary school students in the South East zone. You will note that it will not be easy to enumerate all the members of the population. Again, it will be impractical to sample from every school. You have noted that a researcher is always interested in composing a sample which must represent the characteristics of the target population. But the characteristics of any given population can be quite enormous. Therefore, in cluster sampling, the researcher identifies his research interest characteristics and where or in what areas these characteristics exist. If the population is large or the area is widespread, he may decide to zone the area reflecting these characteristics and then random samples from each of the identified zones.

The emphasis here is on the characteristics of the sub-group and not on individual. For example, in using the population of all junior secondary school students, one may decide to sample schools. It means therefore that any school selected forms a unit of the study. All the students in that school will be used. Another example is that of a researcher who wants to use three Nigerian languages – Igbo, Hausa and Yoruba for his research study. Definitely, he will select the Igbos from the South East, Hausa from the North and Yorubas from the West. This is because, if he wants to get his sample from Nigerians, he may end up getting respondents who are neither Igbo, Hausa nor Yoruba.

Cluster sampling saves time and resources. It is mostly used in research where there is an urge or desire to study the characteristics of respondents in their natural settings or to ensure geographic representation of noted groups whose special characteristics are of interest to the researcher.

3.5.4 Stratified Sampling

In a given population, there exists abundance of population characteristics. A whole range of differences can exist even within a particular characteristic. For instance, in using weight of individuals, you have heavyweights, lighter weights, cruiser weights, feather weights etc. In many educational studies, you will notice that the population is by nature stratified. You have differences in gender, occupation, income, socio-economic status, geographical location, qualifications, age, height, colour, dialects etc.

Stratified sampling is appropriate when the population consists of a number of sub-groups which are homogeneous or contain members that share common characteristics, which need to be represented in the sample. Randomisation is then used to select members from the sub-groups in such a way that the proportion of each sub-group in the population is reflected in the sample.

Stratified sampling is appropriate when the study is required to compare sub-groups or when the sub-groups are likely to influence the level of the dependent variable.

Self Assessment Exercise 5.3:

(i)   What are the major features of probability sampling?

(ii)   What are the probability sampling techniques?

3.6   Non-Probability Sampling

This can be called biased sampling or non-random sampling technique. This is because the chances of an element, person, object, event, thing etc. being included in the sample are not the same. Some may have more advantages than the others. It does not involve randomisation and therefore may have high sampling error and generalisation is limited. The non-probability sampling techniques are further subdivided into:

3.6.1   Purposive Sampling

This is necessitated when the researcher is interested in certain specified characteristics. It ensures that only those that meet such required purpose, attributes or characteristics are selected. For instance, a study of the Vice Chancellors of Federal Universities in Nigeria, or a study comprising Local Government Chairmen in Imo State.

In these cases, you will notice that you can only use those who are Vice Chancellors in Federal Universities or the Local Government Chairmen in Imo State. They are few and are known.

3.6.2   Volunteer Sampling

This is used when every member of the population cannot comply with the demands of the investigation. Therefore, these individuals who are willing to comply with the demands of the investigations are used. These are the volunteers who are willing and ready to cooperate with the researcher.

But this is a biased sample because those volunteers differ from the entire population and from the non-volunteers in many of the characteristics.

3.6.3   Captive Audience

This is just like an intact class used by the teacher for a research purpose. The generalisation should not go beyond the class.

3.6.4   Quota Sampling

In this method, the researcher selects a certain number of respondents in proportion to their number in the population, but without randomisation. For example, where all the states in Nigeria are given quota admissions in federal universities or unity schools.

3.6.5   Accidental Sampling

This can be called availability sampling. This is because it makes use of the respondents available at the time. Participation is based on availability. This is very common with pressmen or journalists. They interview or use anybody available at the time.

4.0   CONCLUSION

From this unit, you have seen that, as a researcher in education, you must randomly compose the sample you intend to use for any investigation. When you use non-random and biased samples, the laws of probability no longer hold. The samples are not truly representative of the target population and so have large number and variety of sampling errors.

The results of such investigations are unsustainable and applicable to the samples alone. Sample sizes that are large and composed using randomisation, have lower sampling errors. The findings provide more acceptable and sustainable basis for inferential decisions and generalisations to the target population.

5.0   SUMMARY

In this unit, you learnt that total population is the universe of individuals, things, objects, events, units, elements etc. possessing the same stated characteristics. Sampling means drawing of samples from a population or populations in research.

A sample is a part of the population. It must be the true representative of the target population in all its parameters or characteristics. Findings made from the samples are generalisable or truly ascribable to the population, if the samples are randomly composed and are representative of the population.

You learnt that there are two major types of sampling techniques. These are:

(1) Probability sampling, which ensures that the sample selected is validly representative of the target population. This is done by employing the mathematical or statistical theory of probability or chance and randomisation in composing the samples. The methods of sampling here include: simple random sampling, systematic sampling, cluster sampling and stratified sampling.

(2) Non-probability sampling, which generate biased samples that are not truly representative of the target population from which they are drawn. The sampling error is large and findings cannot be used for generalisation beyond the samples. Under this, we have purposive sampling, volunteer sampling, captive audience, accidental sampling etc.

6.0   TUTOR MARKED ASSIGNMENT

i.   Differentiate between population and sample.
ii.   Differentiate between probability sampling and non-probability sampling.
iii.   List the probability sampling methods.
iv.   Enumerate the non-probability sampling methods.

Answer to SAE Question 5.1

You can give your own examples for (i) and (ii).

Answer to SAE Question 5.2

(i)   Population is the universe of every person, things, objects, events, units, elements etc. which have the same stated characteristics. But sample is part or subset of the population from which it is drawn.

(ii)   The factors which affect the sample sizes are:

- Expense in terms of time and money;
- Subjects availability to participate in the study;
- Size of the population of the study;
- Management and control abilities of the researcher;
- Complexity of the research conditions and that of the data to be collected and analysed;
- Efficiency in drawing the sample itself;
- Level of cooperation expected of and available from the proposed sample.

Answer to SAE Question 5.3

(i)   The major feature of probability sampling is randomisation in composing the samples.

(ii)   The probability sampling techniques are: simple random sampling, systematic sampling, cluster sampling and stratified sampling.

Answer to SAE Question 5.4

The non-probability sampling techniques are: purposive sampling, volunteer sampling, captive audience, quota sampling, accidental sampling.

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MODULE TWO: RESEARCH DESIGNS

UNIT 6   RESEARCH DESIGNS – INTRODUCTION

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1.0   INTRODUCTION

Most of the times, certain natural events occur. These events may occur in the air, land, sea, inside our brains or inside the body, in our schools and school systems, anywhere and everywhere. These events can become of considerable interest to people who study the various entities and attributes.

Among these people are educational researchers, scientists and researchers from many other fields. You can see that most of the things we use today for our comfort and productivity are the products of one research or the other. We can then say that the products of research are invaluable in all spheres of our human developments.

Therefore, the framework of how we carry out these researches must be clearly defined and universally accepted. It means also that in every field or discipline, the development of the structure of that particular field or discipline and its function to the society, through research, must follow a clearly defined and acceptable framework. It is this framework that provides the modus operandi for research in that particular field or discipline.

In education, this framework which is followed in conducting research is called research design, while the activities carried out within the design specifications constitute the research methodology. In other words, the research methodology is the knitty-gritty work aspect of the research.

In this unit, you will learn more about the research design and in subsequent units, you would learn the types of research designs.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain the concept of research design;
(ii)   discuss the components of a research design;
(iii)   list the types of research designs.

3.0 MAIN CONTENT

3.1 The Concept of Research Design

In the introduction above, you read that the research design is regarded as a framework, a structure to be followed in conducting the research. You will also note that a research design is seen as a master-plan or a blueprint for the research activities which the researcher intends to use in order to carryout a full investigation of the problem of his interest. The research design tells you what to do and how to do it. According to Kerlinger (1973:300), it is "the plan, structure and strategy for investigation conceived so as to obtain answers to research questions and to control variable".

You can see from this description that the design is aimed at providing answers to research questions and the control of variable. These are the two basic purposes of a research design which you should take cognizance of right from the time you formulate your research hypotheses, assumption, questions, etc. to the final analysis of data.

The research design determines the nature and scope of the study which you propose to carry out. Take for instance that you plan to build a house. What are the necessary things you do? You will notice that you design the plan of the proposed house based on the size of your land and based on the funds available, you start to make available the materials to be used etc. The design of the building gives you ideas of the type of materials, the labour and the type of house you are building. In education, a research design is very important because it provides you with the information leading to your knowledge of what kind of method you will use or plan to use.

When you are writing your research project report, your framework or structure should include a section on what type of design as well as why that particular design is used. A very important feature or attribute of a research design is that it must be adequate and appropriate for use in the investigation of the problem of the study. If this does not happen, you will run the risk of being stuck with a dead end or misleading procedures, data and conclusions. You see, this will be

detrimental to your study. It means that different research designs are appropriate for particular types of studies and not for every type of study. Consequently, it is necessary for you to select and equally important, to comply with the best design suitable for your study. You are warned to avoid short-gun approach to research. Let us go to the next section which talks about the components of a design.

3.2   The Components of a Research Design

A typical design in educational research is made up of five major components. These include: sampling, grouping, research conditions, data analysis and conclusion based on the testing hypotheses or answering research questions.

Before we continue, you have to note that it is possible for the type of study you plan to undertake not to include one or more of such components in the design of your study. For instance, some survey researches would not require any research conditions other than administering questionnaires to the samples.

3.2.1   Sampling and Grouping

Research is carried out for the sole purpose of discovering or rediscovering phenomenon in the form of events, laws, principles, occurrences, etc. which have applications that are beneficial to mankind.

Majority of the research studies are not carried out on a whole population. This is because it would be too expensive, unwieldy, time-consuming and perhaps impossible and undesirable. Due to the fact that attributes of any large population are quite numerous and liable to change continuously, it may be impractical and limiting to study them at one and the same time, if at all. The cost and other involvements arising from this would be unimaginably enormous.

Now, imagine you want to conduct a study on NOUN Students numbering about 75,000, throughout the federation. You will need a very bulky research documents, hundreds or thousands of research assistants, thousands of hours of computer and pre-computer analysis work, and so many sleepless nights. If this is so, think of what it will be like when you have populations running into millions.

You will recall that we have defined population as any groups or objects which a researcher wishes to study and which, of a necessity, have one or more common characteristics that are of interest to him/her.

Now that you have seen that it is not possible, practicable or even desirable to study all the attributes of a population, what do you do? You are advised to restrict your investigation to a small fraction of the population or universe of interest to you for your study. This small fraction or subset of the population selected for investigation in the place of the population is called sample. Every participant in a research study constitutes the sample or subjects. You have already noted that the method of composing the sample is called sampling.

You will notice that for research purposes, it is necessary to have two or more groups of subjects. In this case, grouping of the samples becomes necessary. But if only one group is needed, then no grouping is required.

Self Assessment Exercise 6.1:

1. Define the following:
   Population, Sample, Sampling.

2. Is it advisable to study all the attributes of a population? Give reasons to support your answer.

3.2.2 Research Conditions

When you conduct a research study, there are some activities or events which constitute the conditions under which your research is expected to proceed, be observed and to yield required data. These are regarded as the research conditions. They relate to answering of such questions about the research with regards to: who will do what, when will it be done, with what will it be done and how will it be done? Research conditions vary from one type of planned study to another.

In educational researches, some research conditions may involve the administration of questionnaires or the interviewing of the subjects. In some others, the research conditions may simply involve observing and recording certain behaviours exhibited by the subjects. In yet another research condition, it may involve examining, recording and analyzing historical or case study records or classifying events in different categories.

Research conditions may also involve carrying out experiment. In this case, the research conditions are more detailed and demanding. An experiment imposes rigorous research conditions to enable the researcher establish the presence or absence of a cause-effect relationship in the phenomenon studied.

There are two forms of research conditions in an experimental study. These are the treatment conditions and the control conditions. You will study them in details later in this module.

There are some important considerations which you need to take for your effective and efficient handling of the research conditions of your study; regardless of whether it is an experiment or not. You are required to carefully and methodically comply with the clearly pre-determined nature and scope of events which constitute the research conditions. For instance, if you have two or more groups of students and you want one group (A) to use a method of solving Mathematics problem and the rest (B or C) to use another method, you will make sure that no one from group B or C etc. contaminates group A by seeing or using their own method. So you have to make sure that events which constitute the treatment conditions are unique and different from the events that constitute the control conditions.

The next consideration is time. For how long would the events constituting the treatment and control last? How would each be phased, tested, data recorded etc? Who would be involved in doing the different aspects of the research conditions as far as the groups, researcher and the research assistants are involved?

3.2.3 Data Analysis

This means the treatment of data so that they become summarised or reduced to a point they can be meaningfully interpreted. Research data convey little or no meaning unless they are analysed and described. But before you analyse data, you have to know first the scale or the kind of data.

You will recall that data can be nominal i.e. descriptive classification; ordinal i.e. ordered arrangement; interval i.e. relatively constructs distance between judgements; and ratio which has absolute zero. Again, you have to note that the type of data for analysis would determine the type of statistics to be used for such analysis. If you use statistics which are not appropriate for your data analysis, you derive little or no accurate and verifiable meaning from such analysis. Therefore, you should know what kind of data you are collecting in your study and then the appropriate statistical test to be used for analyzing the particular data.

There are two main types of statistics used in data analysis in research. These are the descriptive statistics which are used for describing the data and for answering research questions. The other is the inferential or parametric statistics which are used to make inferences, judgement and/or decisions about a population parameters based on data obtained from the study of the research sample. You will learn more about statistics in Module 4.

Self Assessment Exercise 6.2:

(i)   What is data analysis?
(ii)   What are the two types of statistics?

3.2.4 Conclusion

In the last section, you learned that for you to analyse your data, you must know the type of data that are yielded by the study and the type of statistical tools to be used. You will also note the conditions under which each statistical tool can be used and how they are used for conclusions. Apart from all these, you will need to know what conclusions or interpretations that can be drawn from the results of the statistical analysis. The implication of this is that you have to know or have a sound knowledge of the statistical techniques for analysis and also be able to interpret and conclude your data and research reports accurately. Never mind, the last module of this course will teach you how to do that. It is not easy to get accurate conclusion and interpretation.

Most of the times, well-analysed and accurate data are misinterpreted due to the researcher's ignorance of the level of statistical significance at which to accept or reject a stated hypothesis. Misinterpretation can also occur as a result of discrepancy occurring between statistical significance as observed through data analysis and practical significance as measured from

unstable data collected from questionnaires; opinionnaires or polls etc. so you have to be careful when you interpret your data and when you state your conclusion.

3.3   The Types of Research Designs

There are basically two types of research designs. All studies in education are either descriptive research design or experimental design. Some of the times, we have a combination of both. Included in these two types of designs are historical research, developmental research, case study research, correlational research, survey research, experimental research, designs etc. You will learn more about these designs in subsequent units.

You need to note that in general, the type of design for a particular study could be correctly inferred or derived from the title or topic of study. It means that right from the time you choose your research topic, you are already battling with the choice of the design of the work. If you take a close look at the table below, you will notice that some operational words in your topic direct you to the design for that particular topic.

Table 6.1:   Research Designs and the Nature of Topics

S/N	NATURE OF RESEARCH TOPIC	TYPE OF DESIGN
1.	(a) Relationship between …………. (b) A correlational study of …………. (c) X and Y as a covariant of …………. (d) A comparative study of ………….	Correlational Research Design
2.	(a) Influence of …………. (b) Incidence of …………. (c) Perception of …………. (d) Impact of …………. (e) Evaluation of …………. (f) Attitude of ………….	Survey Research Design
3.	Effect of ………….	Experimental Research Design

4.0   CONCLUSION

In this unit, you have learned that a research design is a blueprint or a master-plan of work for your study. It generally involves you to carefully and systematically put into consideration some thoughts on each of the five components of a typical research design described in this unit. You should consider these components in terms of what you want to do as part of your study, how many subjects would be involved, whether the subjects would be grouped or not, what would be your research conditions, how would you ensure subject compliance to the conditions, what would be the data and what are the tools that can be used appropriately and effectively in analyzing them, as well as the interpretation that can be made from the data analysed.

You must then reach a decision to know if the design is feasible, logical and sensible. All these, you can do as the research study is in progress. Note that if things do not go as well as you have planned in your design, you are advised to modify the components to suit the reality. But any

modification is better made after due consideration and consultation and agreement with your supervisor.

5.0   SUMMARY

In this unit, you have learnt that a research design is a blueprint or plan of action as regards events which upon implementation would enable you to investigate the problem of your study. You have also learnt that there are five components of a typical research design. These are sampling, grouping, research conditions, data analysis and condition. You also looked at some of the major research designs in educational research. We shall look at these designs in details in the next units.

6.0   TUTOR MARKED ASSIGNMENT

1.   What is a research design?
2.   List the five components of a research design.
3.   List three major types of research design.

Answer to SAE Question 6.1

i.   Population is any group or objects which a researcher wishes to study and which have one or more characteristics that are common and of interest to the researcher.

ii.   Sample – is the small fraction of the population selected for investigation in the place of the entire population.

iii.   Sampling is the process of selecting a subset of the population for investigation.

It is not desirable to study all the attributes of a population. It is too expensive, unwieldy, time-consuming and impossible.

Answer to SAE Question 6.2

i.   Data analysis refers to the treatment of data so that they become summarised or reduced to a point they can be meaningfully interpreted.

ii.   The two types of statistics are descriptive and inferential or parametric statistics.

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UNIT 7   HISTORICAL AND DEVELOPMENTAL RESEARCH DESIGNS

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1.0   INTRODUCTION

In the last unit, you studied the concept of research design. In this unit, you are going to study the historical design and touch briefly on the developmental design. For the purpose of this course, research design and research methods are used interchangeably. The purpose of historical research is to reconstruct the past systematically and objectively by collecting data, evaluating them and synthesizing the evidence in order to establish facts and reach verifiable conclusions. Before we continue, let us see what you should be able to achieve after going through this unit.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain the historical research;
(ii)   list the importance of historical research;
(iii)   enumerate the limitations of historical research;
(iv)   state and explain the sources of information;
(v)   discuss the procedure for historical research;
(vi)   explain developmental research.

3.0   MAIN CONTENT

3.1   Introduction to Historical Research

As a way of describing historical research, Lucio and McNed (1969) wrote that historical research in education is having its focus on the determination of relevant and significant features

of the past with the hope of achieving better understanding of the present and of suggesting guidelines for the future. Kerlinger (1979) described it as the critical investigation of events, developments and experiences of the past, the careful weighing of evidence of the validity of sources of information on the past and the interpretation of the evidence.

From these descriptions of the historical research, you have seen that it is a past oriented research it deals with the determination, evaluation and explanation of past events, for the essential purpose of gaining a better and clearer understanding of the present and in order to make a more reliable prediction of the future. Historical research is an attempt to discover what has happened. It is a study of past events in education. The educational historians hope to gain better understanding of present issues in education by studying the past.

Some scholars have argued that historical research is scientific; others have said it is non-scientific. We are not going to make up your mind and belong to one school of thought. Let us say that historical research in education cover broad areas such as history of educational planning and policy, legislation, educational projects and programmes, general educational history, history of different branches and levels of education. Even legal research that involves painstaking examination of the original sources and documentary study, analytical works of a bibliographical nature etc. are classified as historical research.

In all, you can see that a proper investigation in the historical background of some of our educational problems will not only help us in improving such practices at the present, but also help us to shape them to suit both the present and the future.

3.1.1 Sources of Historical Data

There are two main sources of data in historical research. These are primary sources and secondary sources. Primary sources are those sources which contain account of an event or phenomenon given by someone who actually observed the event or phenomenon. It could be an eye-witness account or testimonies, autobiography, oral evidence, remains of manuscripts, certificate, equipment, attendance register, inventories, report cards etc. Primary sources include original documents, photographs or records from eye-witnesses. Have you witnessed an accident before? If you are called to say exactly what had happened as you saw it happened, the evidence you give is a primary source of historical research.

On the other hand, secondary sources are those materials which contain account of an event or phenomenon by someone who did not actually witness the event or phenomenon. These include textbook, newspaper reports, review of researches etc. In this case, a non-observer mediates between the original evidence and the investigator i.e. from a third party.

You would have seen that most of the times, historical data may face authenticity problem. This is due to the source of data. Therefore, a historical researcher is always faced with the additional task of determining the authenticity of his data. This process is called historical criticism. It may be external or internal. External criticism is concerned with the authenticity of the source of information while internal criticism is concerned with the authenticity or validity of information provided by the source. Before we continue to the next section, do the exercise below:

Self Assessment Exercise 7.1:

1.   What is a historical research?
2.   What are the two sources of historical data?

3.2   Importance of Historical Research

Historical research is of considerable importance. They are as follows:

- Historical research provides a clear perspective of the present. This is because current problems or issues like cultural practices are understandable only on the basis of their past history.

- Historical research provides an understanding of the background of current social problems. The understanding provides us with better perspective regarding the facts nd values on which important social decisions are based.

- The literature review which you carry out in your research also emphasise the importance of historical research. It enables you to find out what was already known to past researchers.

- Historical research sometimes helps to predict future trends. A knowledge of how an educator or a group of educators acted or act or behave in the past can enable one to predict how they will act or behave in future in a similar circumstance. Such predication can make important contributions to education.

3.2.1   Limitations of Historical Research

You have seen that historical research is an enquiry which employs the historical method by emphasizing the use of primary and secondary sources of original historical documents and records to make conclusions and inferences on any topic of study.

Historical research works are said to be error and bias bound. It most of the time reflects the lack of precision in its enquiry. The reason is obvious and clear. Most secondary sources of data are found to be subjective. This brings in a lot of errors as things get distorted in the telling of stories, events and things as they had been explained.

Data collected from oral traditions or archives lack authenticity, accuracy and control which a reliable data can give. There is partial or no control and randomization achieved.

3.3   Procedure for Historical Research

In this section, you will study the steps involved in a historical research. These include:

(i)   Identification and definition of the Problem. This involves the location of a problem of historical significance. You may start by looking at problems and topics studied by other educational historians.   You can also look at current social issues such as distance

education, girl-child education, the new 9-3-4 system of education, etc. You can also look at histories of specific educational practices, institutions, movements or individuals. But you must keep to one important criterion for selecting a problem in historical research. It is to ensure that data are available for solving the problem selected.

(ii)   **Collection of necessary Information.** You have to spend tedious long hours searching through documents, manuscripts, letters, diaries, minutes of meetings and other artifacts of history.

(iii)   **Evaluation of Data.** This has to do with the dual process of establishing the authenticity of the source and then the validity of its control. Some historical sources may be genuine, others may be forged. You should question the genuineness and credibility of each source. Where doubt is revealed, such doubts should be indicated in your research report.

(iv)   **Interpretation of Data.** This requires your greatest ingenuity and imagination as well as insight and scholarliness. Otherwise the relative incompleteness and unverifiability of historical evidence allow a greater reliance on subjective interpretation of data in this type of research. Therefore, it is very necessary that you consider your data in relation to one another and synthesise them into generalization or conclusion which will place the overall significance into focus.

(v)   **Writing of the Report.** There is no standard format for reporting historical research. The particular problem or topic determines how the presentation of findings will be made. The report can be made in chronological order or organized as to present the facts according to topic or theme. However, you must be careful with the choice of words. This is because the words used reflect your interpretative framework.

Self Assessment Exercise 7.2:

Enumerate the procedures for a historical research.

3.4   Developmental Research Design

This is a type of descriptive study which involves an investigation of patterns and sequences of growth or changes that take place with time. You can study the development of education in a particular district, or the development of interest patterns in children. Developmental research seeks to ascertain how some dimensions, variables or characteristics of given population change with time. Its thrust generally lies in finding out how these characteristics of the target population change over time, at what rate, in which direction and the factors which possibly contribute to these changes. Developmental research can be longitudinal or cross-sectional.

3.4.1   Longitudinal Research

In this type, the same groups of subjects are studied for a period of time. Observations are carried out on these subjects from time to time within the period of research to note any changes

in the particular characteristics under study. The data are collected and analysed to see if there are patterns and sequences which underlie the development or unfolding of these characteristics. It provides a more valid approach for studying developmental trends.

But it has its own limitations. You will recall that it involves observing the subjects over a period of time. Don't you think that some may drop out on account of transfer, ill-health, or death? What if some thing happens to the researcher to prevent him from continuing the study? It takes a long time to complete. That means that there must be enough funds to sustain the study. If this is not the case, what happens? Again, by the very nature of longitudinal research, modifications are not possible once the study has started.

3.4.2 Cross-Sectional Research

This involves sampling a cross-section of the subjects of varying ages for the study. It means that instead of following the same group of subjects for a very long time, a cross-section is sampled to be observed at the same time. The characteristics of the subjects at different age levels are examined and analysed to reveal possible trends in development. This approach makes it possible for many subjects to be studied at the same time. It is cheaper and quicker.

But it is less accurate than longitudinal research. Because the subjects differ in other relevant respects apart from age, the differences in the developmental patterns and sequences observed at different age levels may not solely be attributable to age alone.

4.0 CONCLUSION

In this unit, you learned two types of research. The historical research involves identifying a problem or topic, searching for and recording relevant sources of historical evidence, evaluating the evidence for authenticity and validity, and synthesizing historical facts into meaningful chronological or any other proper pattern. You also learned that developmental research is of two types – longitudinal and cross-sectional.

5.0 SUMMARY

In this unit, you have been able to understand that historical research is a past oriented research that deals with the determination, evaluation and explanation of past events for the purpose of gaining a better and clearer understanding of the present and in order to make a more reliable prediction of the future. The sources of historical data are primary and secondary sources. You have studied the importance and limitations of historical research as well as the procedure for its conduct. You have also studied the developmental research and you were told that the two types of developmental research are longitudinal research and cross-section research. In the next unit, we shall look at survey and case study researches.

6.0 TUTOR MARKED ASSIGNMENT

1. Describe historical research.
2. Explain the sources of historical data.

3.   What is developmental research?
4.   What are the two types of developmental research?

Answer to SAE Question 7.1

1.   Historical research is a past oriented research which deals with the determination, evaluation and explanation of past events for the purpose of gaining a better and clearer understanding of the present and in order to make a more reliable prediction of the future.

2.   The two sources of historical data are primary sources and secondary sources.

Answer to SAE Question 7.2

The procedures for a historical research are:

(i)   Identification and definition of the problem
(ii)   Collection if necessary information
(iii)   Evaluation of data
(iv)   Interpretation of data
(v)   Writing of the report.

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UNIT 8   SURVEY AND CASE STUDY RESEARCHES

Table of Contents

1.0   INTRODUCTION

Survey, as a systematic means of data collection dates back to the ancient times. You have heard about housing and population census. You have seen people trying to count the number of livestock in a farm, the number of schools in a local government, the number of age grades, markets etc. This is called status survey. It is different from survey research which is more recent.

Survey research, as a distinctive methodological social scientific research, was developed in the 20th century by research workers in sociology. Since then, it has been applied extensively in the fields of education, psychology, anthropology, political science, economics, statistic etc. Today, it is widely employed in the study of significant problems in these fields. It has obviously had profound influence in these fields.

Most journal articles, undergraduate and postgraduate projects are based on survey research. It is very, very popular in educational researches. But do not jump into it quickly thinking that it is less rigorous and less demanding in terms of skills.

It is not true that anybody can undertake survey research. This is because survey research requires a good deal of research knowledge and sophistication. You must know sampling, questionnaire and schedule construction, interviewing, analysis of the data and other technical aspects of survey before you can embark on survey research. Only very few researchers get this

vital and amount of experience. However, do not be scared, your supervisor will help to guide you if you decide to use survey research in your project.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain the meaning of survey research;
(ii)   discuss the types of survey research;
(iii)   describe case study research.

3.0 MAIN CONTENT

3.1 Meaning of Survey Research

Let us start this section by saying that a survey is "a descriptive study which seeks to document and describe what exists or the present status of existence or absence of what is being investigated".

A survey develops a profile on what is and not why it is so. Surveys do not relate one variable to another. Instead, information is sought and collected on the subject of investigation and described. They are used to ascertain the nature of a phenomenon from a relatively large number of cases. If the entire target population is studied, the survey is called census.

As generally conceived, a survey research deals with the study of a group of people or items by collecting and analyzing data from only a few people or items considered to be representative of the entire group. You have learnt about research designs in some details. A survey research makes use of research design like every other type of research. This design specifies how data will be collected and analysed.

From what you have known so far, you can say that the idea of sampling is very fundamental in survey research. Of course, you have seen that it is not possible to study the entire population. Therefore, only a fraction of the population is studied. But the findings are generalized to the entire population.

To this effect, it becomes very important to use an appropriate sampling technique to obtain a truly representative sample. You can now make use of your knowledge of the methods of sampling which you have already studied in Unit 5 Module 1. What we are saying is that representativeness of the sample is critical to survey research. This is to make reliable inferences about the target population from the sample.

After considering the sample, you have to give consideration to other attributes of a good quality survey research. These include the relevance, reliability and validity of the information collected, accurate enumeration, appropriate and accurate measuring instruments for constructs or variables of interest and accurate data collection procedure.

3.2 Classification of Survey Research

Classification of survey research can be done on two schemes. The first classification scheme is on the basis of the procedure, technique or instrument for data collection (see Borg and Gall, 1979 and Kerlinger, 1979).

Using this scheme, we have:

(a) Questionnaire
(b) Interview
(c) Observational, and
(d) Panel surveys.

3.2.1 Questionnaire Survey

Every survey studies which employ the use of questionnaires as the major data collection technique or instrument are called questionnaire survey.

3.2.2 Interview Survey

Here interview constitutes the major technique for gathering relevant information. Interview involves getting out information through verbal interaction between the respondents and the researcher.

3.2.3 Observational Survey

This is the type of survey involving the use of observation to collect data. It involves gathering information through observation for the purpose of measuring variables.

3.2.4 Panel Survey

This employs a definite procedure or technique of data collection. Here, data are collected from a given sample at two or more different time periods. The data are then analysed to discover trends or changes in the opinions of the subjects over the period of time under study. It is suitable for studying trends or fluctuations or changes in the subjects, opinions, attitudes or behaviours. It can be useful in studying how stable a group of people's attitude towards an issue or object is over time or how an identifiable intervening variable can influence such attitudes.

Another way of classifying surveys is by the purpose to which the particular survey intends accomplishing. Here, we have: developmental, descriptive, correlational and public opinion surveys.

We are going to touch briefly on these types too. This is because they have found expression somewhere in this course. So you either have come across them or will come across them subsequently.

3.2.5   Developmental Survey

Read the last unit again on developmental research. You have learnt that it seeks to ascertain how some variables or characteristics of a given population can change with time. It can be longitudinal or cross-sectional studies.

3.2.6   Descriptive Survey

All those studies which aim at collecting data, analyzing them and describing in a systematic manner the characteristics, features or facts about a given population is called descriptive survey. The studies are only interested in describing certain variables in relation to the target population. They are concerned with a description of events as they are. Look at this topic: "The performance of students in Technical Drawing in WASC examination in Imo State".

You will notice that this study is only interested in describing the performance of the students in WASC examinations in technical drawing in Imo State only. It may not be interested in going into details about the causes of the performances. Can you think of any other topic like this? Now take a look at this: "A survey of the in-service training needs of science teachers in the junior secondary schools of Lagos State".

3.2.7   Correlational Survey

In this type of study, you will need to establish whether or not the type of relationship which exists between two or more variables. See the next unit.

Self Assessment Exercise 8.1:

1.   List two topics that can be studied using public opinion.
2.   What are the types of survey research?

3.2.8   Public Opinion Survey

This is usually designed to find out the opinion of people in a given area toward an issue or event that is of interest to the general public in the area. This area can be a large one such as a country like Nigeria, a small town like Etiti, a university campus or even your study centre. Usually, cross-section of the population is sampled and interviewed or given questionnaires to fill. Any results obtained from the sample may be generalized to the entire population. Most of the time, randomization is not used in the sampling method. This makes the generalization invalid. Non-probability sampling is used most of the time. Public opinion surveys are used for prediction of election results and what the people feel about any government programme.

3.2.9   Advantages and Disadvantages of Surveys

- Surveys are relatively cheap and easy means of collecting large amount of data concerning a given problem. It can be costlier than experimental studies, but if you consider the quantum of data collected, you will see that it is no doubt cheaper.

- Surveys permit the use of a great variety of procedures and instruments in data collection. It is possible to use questionnaire, interview, observation, test or a combination of these.

Under the limitations, we can say that surveys do not give indepth data about the characteristics of the population under study. You see that most questions used in survey researchers make the respondents tend to be superficial and do not contain as much detailed information as possible. It limits the generalisability of the responses obtained.

Some responses are faked, but you have no means of detecting which responses are faked, you are compelled to believe in what has been given to you.

3.3   Case Study Research

This is an indepth intensive study or investigation of one individual, a small unit or a phenomenon. When we say a small unit here, we are referring to a family, a school, a church, a classroom, an association, a teacher, an administrator or a group of these.

A phenomenon can be taken as a case or an issue. For instance, the impact of unemployment among university graduates in a local government area, the influence of examination malpractices on the standard of education in Okigwe Education Zone. The impact of cultism on the peaceful coexistence of students in the University of Lokoja, the influence of religious intolerance on the life styles of the Bassa people. Case studies are used for solving specific problems through indepth study for documenting social realities, life cycle, change or growth.

It has a very long history. It started with the ancient Greeks when they based their logic on close one-on-one observation of individuals, events, etc. as basis for the logical conclusions upon which their subjects depended on. Some researchers in education say it is unscientific because of its lack of rigorous research controls, but it has become a major tool of researching on how children learn, the nature and scope of human intelligence etc.

If you study the works of Sigmund Freud, Jean Piaget etc. you will notice they were case studies. The studies on human growth and development were all case studies. The underlying basis for the use of case study is the belief that probing and studying intensely one typical case can lead to insights into our understanding of individuals, events, social units etc. typical to the particular case study. For instance, if you study one case of a cigarette smoker, you have by implication studied other cases involving smokers. This poses a problem of other cases not studied. The implication is that it is risky to draw a general conclusion to other cases based on only one case studied. You have seen that case studies samples are not representative, so their findings are not generalized. But indepth studies may reveal certain relationships that may merit investigation on a wider scale. It means that when you want to use this type of study, you have to exercise extra care and thoughtfulness in selecting a case for investigation that would be fair and adequate representation of a whole range of similar cases.

Case study research may appear simple, but in reality, it is difficult and time-consuming. This is because of the volume of data collected through painstakingly methodical, skill-demanding counselling sessions, interview sessions, data sifting sessions, travels, etc. involved. All these

require efforts, skills and patience. But the major limitation is the non-representativeness of the samples and subjectivity.

Self Assessment Exercise 8.2:

1.   Mention four problems that can be studied through case study research.
2.   What is the major limitation of case study research?

4.0   CONCLUSION

After successfully going through this unit, you have added two more research methods in the pool of research methods available for you to carry out your research project. You have seen that you can use survey research when you have a very large population. In this case, you can employ a sampling technique. But when you need to study a unit or a phenomenon or an event, you can employ the case study research. Whichever type you like to employ, note the merits and the demerits.

5.0   SUMMARY

In this unit, you have learnt that a survey research deals with the study of a group of people or items by collecting and analysing data from only a few people or items considered to be representative of the entire target population.

Survey researches are classified into two major ways. The various types are questionnaire survey, interview survey, descriptive survey, Correlational survey and public opinion survey.

In this unit also, you have studied the case study research which was described as an indepth intensive study or investigation of one individual, a small unit or a phenomenon.

6.0   TUTOR MARKED ASSIGNMENT

1.   What is survey research?
2.   Explain the types of survey research.
3.   What is case study research?

Answer to SAE Question 8.1

1.   Students can list such topics that can be studied using opinion polls.

2.   The types are: questionnaire, interview, observational, panel, developmental, descriptive, Correlational and public opinion survey.

Answer to SAE Question 8.2

1.   Students can mention problems that can be studied using case study research.

2.   The major limitation is the non-representativeness of the samples.

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UNIT 9   CORRELATIONAL AND EX POST FACTO RESEARCH

Table of Contents

1.0   INTRODUCTION

In the last unit, you were able to go through two types of research. These are survey and case study. You have seen that these two are mainly descriptive in nature.

In this unit, you will learn yet another two types of research. These will help to enrich your knowledge on the different types of research designs or methods for your use in your research project works and for your other uses. It will not be possible to touch on all types of research, even though some of them overlap, but you will get enough in this course to carry you along whatever research studies you are embarking on.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   Explain Correlational studies;
(ii)   Discuss the ex-post facto research.

3.0   MAIN CONTENT

3.1   Correlational Studies

This is a type of research study which seeks to establish the type of relationship existing between two or more variables. The investigation will indicate to you the direction and magnitude of the relationship between the variables. A Correlational research aims at investigating the extent to which variations in one factor correspond with variations in one or more other factors; based on correctional coefficients. This research method is concerned with discovering or clarifying relationships among variables through the use of correlation coefficients.

You will have enough details of the correlation coefficient when you get to Module 4. For now, note that correlation coefficient refers to a numerical value which expresses in mathematical

terms the degree of association between any two variables. This value ranges from –1 to +1. You can see that data analysis of Correlational studies yield these special statistics called correlation coefficients for data analysis. There are many types. The most commonly used are: Pearson's Product Moment Correlation Coefficient (r), and Spearman Rank Order Correlation Coefficient (rho or ℓ). There are some others which you can use depending on the condition. These are point bi-serial, the bi-serial, phi or four-fold, tetrachoric, Kendall's tau correlation coefficients and Kendall's coefficient of concordance.

In choosing an appropriate correlation coefficient, you will need to consider the nature of the variables/data. In this case, you need to consider whether they are continuous or discrete. You also need to consider the subsequent analysis to which the coefficient will be subjected.

In a Correlational research, you try to look out for a situation where each increment in a variable 'X' equally shows a corresponding increment in variable 'Y'. When this happens, you conclude that the relationship is perfectly positive. Therefore, the correlation coefficient will be +1.00. Where a decrease in one variable shows a corresponding decrease in the other, you say that the relationship is perfectly negative. Then the coefficient will be –1.00. When you have a zero coefficient, it shows that there is no relationship. If the variables are somehow related, the coefficient value will be between zero and +1.00, where positive relationship exists or between zero and – 1.00 where relationship is negative.

All studies concerning the investigation of relationships between variables make use of Correlational design, e.g. relationships between age and achievement, intelligence and achievement, interest and career aspirations etc.

Correlational studies are appropriate where variables are complex and do not lend themselves to experimental method. They are quite economical. This is because they permit the measurement of several variables and their interrelationships simultaneously and in realistic settings.

You will have to note that Correlational studies do not establish causation. If two variables X and Y are highly related, it does not necessarily imply that X causes Y or Y causes X. This is because there may be another variable that causes both X and Y or one of them. Take for instance an observation of high degree of relationship between performance in Technical Drawing and performance in Agricultural Science, you should not jump into conclusion that performance in Technical Drawing causes performance in Agricultural Science or vice versa. The fact may be that performance in both subjects can be as a result of intelligence.

Correlational studies help you to predict future trends of variables. For instance, a student who performs very well in JAMB is likely to do well in the University. They are very useful for exploratory studies. These are studies in research areas where no previous studies are available.

However, there are some limitations. These include: that they breakdown complex human behaviour into simple components in order to establish some association between them. This is not realistic. Again, they identify only relationship without identifying cause-and-effect relationship. They are less rigorous than experimental design because there is no control over the variables. Some relationship patterns identified are arbitrary and ambiguous.

Self Assessment Exercise 9.1:

1.   What is Correlational research?
2.   Explain two limitations of Correlational research.

3.2   Ex-Post Facto Research

This is another type of research which is non-experimental or field study that can be recognized by the process of studying, analysing and making recommendations about some activities in their natural settings. According to Kerlinger (1974), ex pos facto research is any research in which it is not possible to manipulate variables, to assign subjects or conditions at random. From this description of ex post facto research, you can see that most of the studies which do not fall into experimental designs and do not involve randomization can be regarded as ex-post facto research. Of course, you have been told earlier that the research types some of the times overlap.

In all non-experimental researches or field studies or ex post factor research, inferences are made and conclusions are drawn, just like you have them in experimental studies. The basic logic of using the scientific process of enquiry is the same in both types of research. The conclusions drawn in non-experimental researches are empirical and are as strong as the experimental research. But the findings from experimental research are more convincing than those from non-experimental researches or ex-post facto researches.

A primary characteristic of all non-experimental studies is that it is not possible to manipulate the independent variables. We can now say that all field studies in education are considered ex-post facto research. They fall into two groups, namely:

(i)   Exploratory field research which seeks to find out "what is" rather than predicting relationships between variables or events.

(ii)   Hypothesis testing field research which is directed towards testing theories and establishing facts in natural or true life settings.

Gay (1976) describes field studies as ex-post facto research and sees them as scientific inquiries aimed at discovering the relationship and interaction among sociological, psychological and educational variables in real social structures and situations. Every field studies are usually carried out to fulfill a number of recognized purposes. These include:

•   discovering significant variables in the field or true life settings;
•   discovering relationships among variables in true natural settings;
•   laying the groundwork for more systematic and rigorous testing of hypotheses that are stated to test theories and establish facts.

Self Assessment Exercise 9.2:

(i)   What is ex post facto research?
(ii)   What are the major differences between ex-post factor and experiment?

3.2.1 Advantages and Disadvantages of Ex-Post Factor Research

The advantages and disadvantages of this type of research are as follows:

(a) **Advantages**

   (i) They are conducted in real life settings, i.e. they have natural strength. They are considered strong in realism, in significance by straight of variables, in theory orientation, by their heuristic or inquiry quality. You can see, this is the reason why it is very popular in educational researches. All educational studies are carried out in true life settings like the school which has the elements of realism in meaning, purpose and condition and also in the findings generated.

   (ii) There is hardly any recorded criticism about it being artificial. It is natural in all parameters representing true life phenomena.

   (iii) It is regarded as being highly heuristic. Although there are some difficulties in carrying out the research, yet field study researchers have always kept their scope of inquiry upon investigation of defined problems, to which verifiable answers are sought through scientific method of inquiry.

(b) **Disadvantages**

   (i) It is a weak method of carrying out empirical research. This is because the statements of relationships have been noted to be weak. The field situation has a plethora of variables and variances in existence. These make it difficult to have definite relationships between the variables.

   (ii) There is lack of control and manipulation of independent variables in the research designs.

   (iii) There is lack of precision in the measurement of the field variables. There is methodological weakness. These weaknesses can be attributed to the great complexity of field situations and the difficulties of quantifying and measuring some variables and their relationship with others in a real situation.

   (iv) Other problems though preventable, are practical problems such as feasibility, cost, sampling method, time factor etc.

4.0 CONCLUSION

In this unit, you have been able to go through two research methods which are descriptive or non-experimental studies. You have seen their characteristics, advantages and limitations.

Therefore, you can use them when the conditions are applicable to your need and situation.

5.0 SUMMARY

You have seen that Correlational studies seek to establish the type of relationship existing between two or more variables. It makes use of Correlational design and correlation coefficients which range from –1.00 to +1.00. It helps to predict future trends of variables but identifies only relationship without identifying cause-and-effect relationships.

You also learnt that ex-post facto research is a non-experimental study in which it is not possible to assign subjects or conditions at random. It is conducted in a real life or natural settings. It is highly heuristic, but it is a weak method of carrying out empirical research.

6.0 TUTOR MARKED ASSIGNMENT

1. In your own words, explain Correlational research.
2. What is ex-post facto research?
3. Give the disadvantages of ex-post facto research.

Answer to SAE Question 9.1

Correlational research is a type of study which seeks to establish the type of relationship existing between two or more variables.

The limitations are that:

(i) It tends to breakdown complex human behaviours into simple components in order to establish some association between them;

(ii) It identifies only relationships without identifying the cause and effect relationships;

(iii) There is no control over the variables;

(iv) Some relationships identified are arbitrary and ambiguous.

Answer to SAE Question 9.2

1. Ex-post facto research is a non-experimental research which is conducted in a real life setting. It is not possible to manipulate variables, to assign subjects or conditions at random.

2. Most of the studies which do not fall into experimental designs and do not involve randomization can be regarded as ex-post facto research.

3. The findings from experimental research are more convincing than those from non-experimental researches or ex-post facto researches.

4. A primary characteristic of all non-experimental studies is that it is not possible to manipulate the independent variables.

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UNIT 10 EXPERIMENTAL RESEARCH DESIGNS

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1.0   INTRODUCTION

In the preceding units, you have studied research designs which are descriptive in nature. You have noticed that these design types have been criticized for a number of reasons.

In this unit, you are going to learn about a parametric research design which is mainly concerned with the identification of the presence of cause-and-effect relationship between the independent and dependent variables. This type of design will enable you to test hypotheses upon which valid, reliable, duplicable and verifiable conclusions are premised.

Experimental design provides you with a rigorous and scientific approach to investigating a problem. Before we continue, let us first list the objectives.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain experimental design;
(ii)   list the basic considerations in the choice of design;
(iii)   describe the variables under study;
(iv)   discuss validity in experimental studies;
(v)   enumerate threats to internal and external validity;
(vi)   describe the types of experimental design.

3.0   MAIN CONTENT

3.1   Experimental Design: An Introduction

According to Borg and Gall (1971:363), experimental design is "the ultimate form of research design, providing the most rigorous test of hypothesis that is available to the scientist". In their own definition, Ary et. al. (1972:26) describe experimental design as "a scientific investigation in which an investigator manipulates and controls one or more independent variables and observes the dependent variable or variables for variation concomitant to the manipulation of the independent variables".

From these definitions and others, you will see that the major purpose of experimental design is to determine what may be. You will note that the two most important conditions necessary for true experimental design are randomization and control over independent variables. It means that you should be able to manipulate the independent variable and observe its effect on the dependent variable. Again, you should do your selection of research subjects by randomization.

For the purpose of classification, the independent variable is conceived in the design as the one variable experiencing some change as a result of manipulation or control by the researcher. This change or manipulation exercises some effect on the other variable which is regarded as the dependent variable.

In the experimental design, two groups are usually compared based upon some criteria. One group is the control group which is normally used as a standard for comparing the effect of the changes or manipulations in the other group. This group which receives the treatment is called the experimental or treatment group.

Before we get to the experimental design proper, you will have to note that most of the times; true experimentation is not possible with educational problems. This is because most subjects with which educational researches are conducted are already selected groups found in natural settings. Take for instance, as a researcher; you want to conduct a study on the best method of teaching a subject like Technical Drawing or Introductory Technology, or the effectiveness of two teaching methods in Mathematics. You can manipulate the teaching methods as independent variables. But the students are already selected. The selection was done during admission period, so random selection is not possible. But the best you can do is to assign the students randomly to the experimental methods or groups. In other words, when you are able to exert partial instead of full control over the subjects and the time or situation for which you can expose them to the experimental stimuli (methods), the design is called quasi-experimental design. Now let us go to the basic considerations in the choice of designs.

3.2   Basic Considerations in the Choice of Design

An experimental research demands a thorough analysis of the problem which would yield a clear, definite and well-focused problem statement. Therefore, when you design an experiment, you seek a design that will yield the desired information at a minimum cost. This means that the statement of the problem must not be vague, loose or poorly formulated. Again, your statements of hypotheses have to be clear. This is because hypotheses form the nucleus of scientific research and they act as facilitating devices which give the facts you obtained a chance to confirm or deny if stipulated relationships exists among educational variables. According to Van Dalen (1973), a brilliantly executed experiment is of little value if it tests a poorly developed hypothesis.

Another consideration here is that of data collection. You need to find out the type of approach that will yield the type of data necessary to test your hypotheses adequately. After this, you will examine your instruments for data collection. The instrument used must be appropriate and suitable for your purpose. You can construct your own, adapt or adopt available instruments.

You also need to define and identify the units of your target population. You will also need to consider how to draw an adequate representative sample from your population. Use the proper sampling technique in order to eliminate elements of bias in the results of your findings. Use randomization or other procedures to assign subjects, teachers, classrooms, materials etc. to groups.

You should also try to identify and control the threats to internal and external validity of the experimental design. This is to ensure that interpretations are non-equivocal.

You should consider and select the simplest, cheapest and fastest method of data collection that is readily available and which meets your needs. You will need to decide earlier in the planning how you will secure and breakdown your data. You should take precautionary measures in collecting, recording data objectively and accurately and checking for errors in procedures, observing, phenomena and making mathematical or statistical computations.

What graphs, tables, and figures do you need for your data presentation and analysis? What type of statistical analysis are you going to employ in interpreting the relationship of variables? These should be carefully considered with the corresponding decision rules for testing hypotheses. You should state the results of the experiment in terms that are meaningful to all persons interested in the experiment.

The basic considerations can be summarised in these question forms:

(i)   Has the problem been clearly and properly stated?
(ii)   Have the hypotheses been clearly formulated?
(iii)   Are the variables and terms defined in clear and unequivocal terms?
(iv)   Is the design clearly described, will it answer such questions raised by the hypotheses?
(v)   Have all potential sources of threats to internal and external validity been carefully checked?
(vi)   Are extraneous variables recognized and effective measures taken to control them?
(vii)   Have randomization methods been used to select subjects from the population?
(viii) Have randomization been employed to assign subjects to groups?
(ix)   Is the population of the study well-defined?
(x)   Is the sample representative of the population?
(xi)   Is the sampling method adequate and clearly specified?
(xii)   Is the sample sufficiently large and drawn in a manner to represent the characteristics of the population?
(xiii) Are appropriate methods used for the collection and analysis of data?

3.3   Variables under Study

A variable is a qualitative or quantitative entity which can take on different values or levels. It can also be described as the conditions or characteristics which the researcher or the experimenter manipulates, controls or observes to obtain results. For instance, age is a variable. It can be of several continuous values. Gender is another one. It can be male or female. In experimental designs, there are so many and varied variables with different names. Let us now look at some of them.

3.3.1   Independent and Dependent Variables

The conditions or characteristics which you manipulate in order to find out their relationships with the observed phenomena are called independent variables. These are also called

experimental or treatment variables. In educational research, such variables like methods of teaching, reward, instructional materials, aye, sex, race, location, qualification or experience of teachers etc. are examples of independent variables.

The conditions or characteristics which appear disappear or change as the researcher or experimenter manipulates the independent variables is called dependent variables. Note that by manipulation, we mean such actions like apply, remove, or change etc. When you measure a variable to determine the effects of the experimental treatment on it, it is referred to as the dependent or criterion variable. For instance, changes in students' performance resulting from the influence of independent variables, measured speed in accomplishing a task or a test score, measured changes in academic achievement of students as a result of the introduction of computer managed learning etc. are some examples of dependent variables. Before we go to the next section, note that the manipulated variable is the independent variable. Its effects are observed on the dependent variable.

3.3.2   Continuous and Discrete Variables

All the variables which yield continuous data are called continuous variables. Continuous data are those which can be in both whole and fractional numbers e.g. time can be in hours, minutes and seconds, length can be in meters, centimeters and millimeters, aye can be in years, months and days, including the fractions of these. For example, 5.5 seconds, 5.3 seconds etc. or scores – 20.5%, 45%, 52.6% etc.

All variables which yield only whole numbers and no fractions are called discrete variables e.g. sex – man and woman group = group 1, group 2 or group A and group B. There is no 2½ man or group 1½. It can only be whole numbers.

3.3.3   Intervening and Extraneous Variables

The intervening variables are the unwanted variables that intervene between the cause and the effect. They may not be controlled or measured directly, but may have some important effect on the outcome of the experiment. They tend to modify the effect of the independent variable on the dependent variable and therefore, must be identified and removed or prevented.

Take for instance, in a laboratory experiment, some factors like fatigue, anxiety, motivation, patience; carelessness etc. may influence the result, even though they cannot be observed directly. These are intervening variables. You have to take care of them by holding them constant or equalizing their presence in the experimental and control groups.

Extraneous variables are those variables not manipulated by the experimenter but which may have significant influence on the dependent variable. They have to be controlled; otherwise they distort and invalidate conclusions that result from the findings. For example, if you want to assess the effectiveness of a newly developed programme in access physics in NOUN. At the beginning of the semester, you select 200 students in the Access Programme of NOUN to participate in the new programme. You have to make sure that all the participating students meet the necessary requirements for participation. After allowing these students to participate in the

programme for one semester, you give them an achievement test. If you discover that there are large statistical significant gain in the students' achievement in physics, will you safely conclude that gain in the students' achievement experimental treatment which is the access programme in physics. Unless such extraneous variables like history, testing, maturation, instrumentation etc. have been adequately controlled. We shall look at these in the next two sections.

Self Assessment Exercise 10.1:

1. Explain the following: experimental design and variables.
2. Discuss the types of variables in experimental research.

3.4 Validity in Experimental Studies

The main purpose for which experimental research is conducted is to make a significant contribution to the development of knowledge. For this to take place, the experiment must have two types of experimental validity. According to Campbell and Stanley (1966), these are internal validity and external validity.

3.4.1 Internal Validity

An experiment has internal validity to the extent that the independent variables (manipulated factors) actually have genuine effect on the dependent variable (observed consequences) in the experimental setting. In other words, the outcome or result of the study must be a function of the programme or approach being tested and not the result of other causes not systematically dealt with in the study. That is to day that the experimental treatment must bring about a change in the dependent variable. The independent variable must be the one to really make a significant difference in the dependent variable. Therefore, your design must provide adequate control of extraneous variables. If your design can eliminate these extraneous variables which could lead to alternative interpretations, then it has contributed to the internal validity.

3.4.2 External Validity

External validity is the extent to which the results obtained from an experiment can be generalized to non-experimental situations such as populations, settings, experimental variables and measurement variables. As a researcher, you would end up achieving nothing or little of practical value if observed variable relationships were valid only in the experimental setting and only for those participating in the research. You have to make generalizations from the observed to the unobserved. For this to take place, you need some kind of assurance. The most important is that the sample of events studied must be a representative of the target population to which results are to be generalized. The degree to which the result of your experiment can be generalized to different subjects, settings and measuring instruments gives you the degree of external validity.

Note that it is not always possible for external validity to be achieved completely. This is because internal validity is very difficult to achieve in a non-laboratory setting especially in the behavioural experiment where so many extraneous variables have to be put under control to

achieve internal validity. By so doing, you create more artificial, less realistic situations which reduce the external validity or the generalisability of the experiment. You may ask what you would do in this situation. The answer is that you have to compromise a little and try to strike a possible and reasonable balance between control and generalization.

3.5   Threats to Internal Validity

We have said that educational or behavioural experiments conducted outside the laboratory settings are susceptible to a number of extraneous variables. These influence the results of the experiments in ways difficult to evaluate. You have been told that these variables cannot be eliminated completely, but many of them can be identified. You need to anticipate them and try to minimize their influence through sound experimental design and execution. The identified extraneous variables that frequently represent threats to internal validity of a research design as listed by Campbell and Stanley (1966) and Cook and Campbell (1979) are:

3.5.1   History

Some events in the environment may occur at the same time the experimental variable is being tested. These events may produce changes or affect the subjects in addition to the independent variables. For example, you have decided to find out whether students boarding enhances academic performance. By the time you are conducting this study, a wind disaster occurred in the school damaging roofs and other things, such that the students' activities were disrupted. If you go ahead in this experiment, the measured outcome may not reflect the actual result but that of the external historical event.

3.5.2   Maturation

With the subjects, changes can occur in many ways over a period of time. Such changes can be in the form of subjects getting older, hungrier, bored, tired, wiser, less-motivated, more stressed up etc. These changes can influence the dependent variables and be confused with the independent variables.

3.5.3   Pre-testing

Pre-testing at the starting of an experiment may produce a change in the subjects. This is because tests may sensitise individuals by making them more aware of the purposes of the researcher and may serve as a stimulus to change or it may ginger them to change by reversing and redoing the pretest.

3.5.4   Measuring Instruments

When you use unreliable instruments or techniques to describe and measure aspects of behaviour, they become threats to the validity of the experiment. Tests used as instruments of observation must be accurate (valid) or consistent (reliable), otherwise a serious error will be introduced. If you use human observers to describe behaviour changes in subjects, you have to

gird against changes in standards due to fatigue, increased insight or skill or changes in evidence of judgement over a period of time.

3.5.5 Statistical Regression

This can be seen as the tendency for extreme scores to regress or move towards the common mean on subsequent measures. For example, some subjects may score very high on a pretest and score very low on a posttest whereas some who scored lowest on the pretest may score very high on the retest. You have to recognize that in pretest-posttest situations, there is a normal regression towards the mean. It means that the initially highest and lowest scoring subjects may not necessarily be the highest and lowest achievers.

3.5.6 Differential Selection of Subjects

Whenever subjects are not selected or assigned randomly to different levels of treatment, it results in bias. Non-equivalence of experimental and control groups can be noticed if one group is brighter, more receptive, older etc. than the other group. Randomization must be used to avoid this.

3.5.7 Experimental Mortality

Loss of subjects or mortality as a result of deaths, transfers or relocations, or subjects dropping out of the experiment before it is concluded is referred to as attrition. Attrition of subjects may not be random. It means that those who complete the experiment may have peculiar characteristics. These may limit the generalisability of the results. Attrition also distorts the equivalence of groups making it difficult to determine the contribution of the independent variables. For example, if most of the people who scored lower on a pretest decide to dropout of the experimental group, the group may have a high mean performance on the final result. To avoid attrition, use shorter duration for your study; and reinforce the participants.

3.5.8 Specialised Samples

When samples are selected from specialised groups such as university students, NOUN students, gifted children, private schools or from a limited geographical area, the findings cannot be generalized outside the group or area. Samples must be selected to be representative of the population of study; otherwise the study must be replicated in other contents to make it externally valid.

3.5.9 Instrument Reactivity/Instrumentation Problems

When, as a teacher, you notice that your lesson is being recorded, your behaviour may change. The attitude of the respondents may change because of the presence of recording instruments. Take for instance; when you are assessed in your teaching practice, you see that you put up a spectacular performance when your supervisor is present. Even the students behave very well. But after that what happens?

Measuring instruments may go faulty. The investigator may use the instrument incorrectly. Measured values may be interpreted incorrectly. Instrumentation problems, as listed, result in measurement error. You have to identify all sources of measurement errors, estimate them and adjust or eliminate them.

3.5.10 Interactive Combination of Factors

Some of the times, the factors which affect internal validity occur in combination. For instance, selection, maturation, history, interaction may occur as a source of invalidity. So you have to gird against them both in isolation and in combination.

Self Assessment Exercise 10.2

i.   What is internal validity?
ii. What is external validity?
iii. Explain the threats to internal validity.

3.6   Threats to External Validity

External validity is concerned with the extent or degree or power with which the experiment generalizes variable relationship to a wider population of interest. In other words, if you have established a valid relationship between variables A and B in your classroom experiment, the questions to be asked are: Is this relationship obtainable in non-experimental settings for other students in other schools, in other socio-economic levels, in other types of communities and in other geographic areas?

In conducting your experiment, you have to be aware of quite a number of threats to external validity so as to make attempts to minimize them. To Bracht and Ecass (1968), there are two types of external validity. These are population validity and ecological validity.

Population validity involves the identification of the population with which the results of the experiment are generalisable.

Ecological validity involves the generalisability of external effects to other environmental conditions. When we break these two categories down, we have the threats to external validity as:

3.6.1   Hawthorne Effects – Placebo

Hawthorne effects are named after the Western Electric studies in industry (Roethlisberger and Dickson, 1939). They are distractions in behaviour which can arise when participants in an experiment have the knowledge that they are subjects of a study. In other words, the behaviour of subjects are influenced when they know that they are being used for a study. Take for instance, when you had your teaching practice, immediately you know that your supervisor is coming, what did you do? You tried to put up a spectacular performance to impress him/her. Even your students behaved well. Is this the true picture? After the supervisor had gone, what

happened? Back to square one? You see, the result of the assessment is influenced by the fact that you and your students know that it is an assessment exercise.

3.6.2   Experimental Settings tend to be Artificial

When you attempt to control extraneous variables, you impose careful controls. These may introduce a sterile or artificial atmosphere which is not at all like the real life situation for which generalizations are desired. This in itself is a threat.

3.6.3   Selection Bias

You have learnt that selection bias is a threat to internal validity when you have to compare non-equivalent experimental and control groups. It can also become a threat to external validity when samples are selected from non-representative populations. To avoid this, use randomization.

3.6.4   Multiple-Treatment Interference

If two or more treatments are administered consecutively to the same person with the same or different studies, it becomes very difficult to ascertain the cause of the experimental results or to generalize the findings to settings in which only one treatment is present.

3.6.5   Testing

Pretesting poses a threat to external validity if generalisation is made to populations that have not been pre-tested.

3.6.6   Novelty and Disruptive Effects

The newness of a treatment, the enthusiasm or disruption when there is a change may influence the result of an experiment.

Self Assessment Exercise 10.3:

Explain the factors which are threats to external validity.
Having discussed validity of experimental design, we will next discuss types of experimental design. There are thee major types;-

3.7   Pre-Experimental Designs

Before we go into this section proper, let us look at the symbols we shall be using. These are:

R   =   randomization in the assignment of subjects to groups
X   =   treatment or experimental variable
C   =   control group
E   =   experimental group
O   =   a measure of the dependent variable

Pre-experimental designs can be regarded as non-experimental designs. This is because they provide little or no control of extraneous variables. In other words, experimental designs are classified according to the degree of control provided. Now let us go to the designs here.

3.7.1 One Group Post-test Design

In this design, treatment is given to a single group and a post-test to measure the effect of the treatment is administered. This is represented thus: X O

This has a lot of weaknesses, including, lack of control group, lack of information about the experimental group. There is difficult and no justification to say that X cause O.

3.7.2 One Group Pre-test post- test Design

In this design, one group is observed or measured with a pretest, subjected to treatment and then observed or measured a second time with a post-test. Comparisons are made with the level of the dependent variable before and after treatment. The differences in pretest, post-test are attributed to the treatment. It is represented thus: O_1 X O_2.

For instance, if you, as a teacher, decide to introduce the use of a new text/workbook and to see the effect on the performance of the pupils. You may decide to give them a test, after which you teach them with the new text/workbook, and later give the pupils another test. You now compare the pretest and post-test. Any difference will now be attributed to the introduction of the new text/workbook. This has a lot of weaknesses including lack of control for history, maturation, pretest sensitization, statistical regression and lack of control group to make comparison possible.

3.7.3 Two Groups Static Design (Static Group Comparison)

In this design, two groups that are not equivalent are used. One group is exposed to the treatment. It can be represented thus:

$$E \ X \ O_2$$
$$C - O_2$$

The measures of the dependent variable O2 for the groups are compared to determine the effect of the treatment. The weakness here is that of lack of randomization and matching of the groups.

3.8 True Experimental Designs

The type of designs in this category provide adequate controls for all sources of internal validity, however it is difficult to meet the conditions for its use in educational research. Now, let us look at some of the designs here.

3.8.1 Post-test Only Control Group Design

This is a very simple, but powerful experimental design. It makes use of two groups. One group experiences the treatment while the other does not. The groups are selected and assigned through randomization. The design therefore controls all threats to validity and sources of bias.

R E X O
R C – O

At the end of the experiment, the post-test scores of the two groups are compared.

3.8.2   Pre-test-Post-test Control Group Design

In this design, the subjects are assigned to the groups by randomization. The two groups are given pretest on the dependent variable. Treatment is only given to the experimental group for a specified time. Then the two groups receive post-test on the dependent variable. The average difference between the pretest and post-test i.e. $O_2 – O_1$ found for each group and compared.

R E O_1 X O_2
R C O_1 – O_2

The significance of the difference in average changes must be determined by an appropriate statistical test like t – or – f-test.

You will have to note that sections 3.8.1 and 3.8.2 can be expanded to a multiple group design by introducing n values or levels of the independent variable.

3.8.3   Solomon Three and Solomon Four Group Design

In these designs, three and four randomized groups of subjects are used respectively. These experimental designs were designed by Solomon (1949). A second and third control groups are used respectively. The difficulty inherent in the randomized group, pretest – post-test design is overcome because of the second and third control groups. The O_2 measures are then used to assess the interaction effect through a comparison of the O_2 scores of the three or four groups.

A. Solomon Three: (R)   E O_1 X O_2
                       (R) C_1 O_1 – O_2
                       (R) C_2 – X O_2

B. Solomon Four: (R)   E O_1 X O_2
                       (R) C_1 O_1 – O_2
                       (R) C_2 – X O_2
                       (R) C_3 – – O_2

3.9   Quasi-Experimental Designs

Experimental designs which offer less well controls and rigorousness are called quasi-experiment. This situation can arise when full experimental controls through randomization are not possible.

Most educational experiments fall into this category. Now let us see some of the examples.

3.9.1 Non-Equivalent Control Group, Pretest-Posttest Design

This option can be used when you cannot randomly sample and assign your subjects. The groups are used as already in existence or organized, like classes, members of some social clubs, classroom schedules etc. A pretest is given to the two groups. The scores are analysed. Then treatment is given to the experimental group. After the treatment, the post-test is given to the two groups.

$$E \ O_1 \ X \ O_2$$
$$C \ O_1 \ - \ O_2$$

The t-test statistics can be used to compare pretest post-test change in scores, but the analysis of covariance (ANCOVA) is used to adjust for initial group differences.

3.9.2 Counterbalanced Design

This design can be used with intact class groups. The groups can be totalled at intervals during the experiment e.g.

Replication	X_1	X_2	X_3	X_4
1	GP A	B	C	D
2	GP C	A	D	B
3	GP B	D	A	C
4	GP D	C		B
5	GP D	C	B	A
	Column mean	column mean	column mean	column mean

This design is different from others in that every subject receives every experimental treatment at sometime during the experiment. It involves series of replication shifting the experimental groups, such that at the end of the experiment, every group has been exposed to every treatment.

3.9.3 Time Series Design

In this design, the selected subjects are measured on the dependent variable at fixed periodic intervals using the same test. After series of measurements, the experimental treatment condition is introduced and the subjects are exposed to it. After treatment, the subjects are again subjected to series of measurements at fixed interval. Thus, we have:

$$O_1 \quad O_2 \quad O_3 \quad O_4 \quad X \quad O_5 \quad O_6 \quad O_7 \quad O_8$$

The effects of the treatment are determined based on the change or gain in the test results immediately after treatment. So any difference in performance after treatment is taken to be attributed to the treatment.

Its major weakness is that it is not sensitive to controlling extraneous validity threats of history, maturation, reactive effects of the tests etc.

3.10   Factorial Design

These are modifications of the experimental designs with further complication that additional independent variables called control or secondary variables are included in addition to the treatment variable. In other words, it is possible to manipulate several independent variables at the same time and observe their effects on the dependent variable. The combined effects of two or more variables due to interaction can also be investigated.

The simplest is the two-by-two (2 x 2) factorial design which has two independent variables each of which takes on two levels or values e.g. if you want to use individualized instruction as a method of teaching. You create two levels of the task, as problem solving and discussion methods, then you have the intellectual ability taking on two levels, such as high achievers and low achievers. We shall have:

Experimental Variable X1 = Individualised Instruction

Control Variable X_2	Treatment A = Problem solving	Treatment B = Discussion	
High achievers Low achievers	Cell 1 = 80.5 Cell 2 = 60.3	Cell 3 = 70.6 Cell 4 = 45.8	Mean Mean
	Mean =	Mean =	

The difference in the mean scores is compared. If the difference is significant, then there are main effects of treatment. From the above example, you can see that the high achievers scored higher in both problem solving and discussion method. You will also notice that there are four means, two for the columns and two for the rows. They represent means for the two methods of treatments and means for the two levels of achievement. These means are compared.

There are other types of designs such as Hierarchical design and multivariate designs etc. These are meant for you to cover when you go to the advanced research methods.

4.0   CONCLUSION

In this unit, you learnt that experimental research provides a logical, systematic way for answering questions and discovering new knowledge as well as finding the relationships between variables. You know that before you can secure the desired outcome in an experimental setting, you have to manipulate certain variables or influences and observe how the behaviours of the subjects are influenced or changed. At the same time, you need to control or isolate certain variables in such a way that you can be reasonably sure that the effects you observe can be attributed to the variables which you are manipulating rather than to chances or some other

uncontrolled influences. You also learnt that the design of an experiment involves the process of planning the experiment i.e. the order in which the experiment is run.

5.0 SUMMARY

In this unit, you read that an experimental design is the plan of procedures that enables you to test hypotheses and reach valid conclusions about the relationships between the dependent and independent variables. You also looked at the basic considerations in the choice of designs, the variables under study which are independent, dependent, continuous, discrete, intervening and extraneous variables. In this unit, you have been able to see the two types of experimental validity, these are: internal validity, which is the degree to which the independent variables actually have genuine effect on the dependent variables in the experimental setting; and the external validity which is the extent to which the results obtained from an experiment can be generalized to non-experimental situations.

The threats to internal validity are: history, maturation, pretesting, measuring instruments, statistical regression, differential selection of subjects, experimental mortality, specialized samples, instrument reactivity/instrumentation problems and interactive combination of factors.

The threats to external validity are Hawthorne effects, experimental settings tending to be artificial, selection bias, multiple-treatment interference, testing, novelty and disruption effects. You did study the types of experimental designs from pre-experimental designs, true experimental designs, quasi-experimental designs and factorial designs.

6.0 TUTOR MARKED ASSIGNMENT

 (i) What is an experimental design?
 (ii) Mention the variables in experimental study.
(iii) Explain the two types of experimental validity
(iv) What is the major difference between true experimental and quasi-experimental designs?

Answer to SAE Question 10.1

Experimental design is the plan of procedures that enables the researcher to test hypotheses and reach valid conclusions about the relationships between the dependent and independent variables.

Variables are qualitative and quantitative entities which can take on different values or levels. They can also be described as the conditions or characteristics which the researcher manipulates, controls or observes to obtain results.

There are many types of variables in experimental designs. They are: independent, dependent, continuous, discrete, intervening and extraneous variables.

Answer to SAE Question 10.2

Internal validity is the degree to which the independent variables actually have genuine effect on the dependent variables in the experimental setting.

External validity is the extent to which the results obtained from an experiment can be generalized to non-experimental situations.

The threats to internal validity are: history, maturation, pre-testing, measuring instruments, statistical regression, differential selection of subjects, experimental mortality, specialized samples, instrument reactivity, instrumentation problems and interactive combination of factors.

Answer to SAE Question 10.3

The threats to external validity are: Hawthorne effects, antifficiality in experimental settings, selection bias, multiple-treatment interference, testing, novelty and disruption effects etc.

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MODULE 3:   DATA COLLECTION INSTRUMENTS

Unit 11   Observation Technique
Unit 12   Questionnaire
Unit 13   Interview
Unit 14   Others Methods of Collecting Data
Unit 15   Validity and Reliability of an Instrument

UNIT 11   OBSERVATION TECHNIQUES

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1.0   INTRODUCTION

In the last module, you worked through the various designs that you can use in your educational research. In this module, we are going to look at the major ways of collecting data for your research. The first among these methods is observational technique.

Observation, as a method of data collection or obtaining information in research, involves measuring variables or gathering the data necessary for measuring the variables. A variable is measured so that it can be related to other variables. Before we continue, let us look at the objectives of this unit.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain the observational technique of data collection;
(ii)   describe observational variables;
(iii)   explain the phases of observational method;
(iv)   discuss the recording of observations;
(v)   describe the validity and reliability of observations;
(vi)   highlight the problems of observation, and
(vii)   list the advantages and disadvantages of observation.

3.0   MAIN CONTENT

3.1   Observational Technique: An Introduction

Observation can be regarded as a process of looking out and recording the presence or absence of a particular trait or behaviour of a person or group of persons. According to Nworgu (1991), observation, as a method of data collection, involves watching people, events, situations or phenomena in order to obtain first-hand information about a particular aspect of such person, event, situation or a phenomenon. Some of the times, you may have certain information relating to some aspects of human behaviours which may not be easy to obtain except you are in that particular setting where such behaviours are exhibited. It may not surprise you that most of the times information provided by respondents in questionnaires and interviews can be inaccurate, prestige-based or faked. But observational techniques make it possible for you to obtain first-hand information about the person, object, event, situation, phenomenon or object-event interaction of interest.

In other words, instead of using the other methods which can easily accommodate response faking and personal bias, you can decide to obtain your information directly by means of naturalistic observations. For instance, if you are a technical instructor and you are required to fill in a questionnaire and list the methods you use for teaching prevention of accidents in the school workshop, what will you do? You will go and list the best and current methods available, whether you use them or not is another thing. But if you are watched at random while teaching your class, we may be able to obtain the actual methods used. Observation characterizes or is used in all types of research, be it experimental or non-experimental. Observation techniques are challenging. They need to be planned and carried out in a systematic way.

3.2   Observational Variables

Anytime you have decided to conduct a research that requires the use of observation, it is necessary that you identify and define the observational variables. You know that human behaviour is complex and as such important characteristics and/or traits are very difficult to observe directly. You must therefore, try to define them precisely in operational terms. For instance, if you have a problem about teachers' attitude to work, you will first understand that the problem is broad, can suggest the use of observations, but it requires the determination of the

specific observations that should be made. You have to develop such expectations that you think signify attitudes to work. After this, you have to limit the focus of your observation considerably by defining the important variables to be observed and recorded based on your expectations.

For example, a typical expectation will be that teachers who have positive attitude to work are always punctual to their classes. At this juncture, you should define the behaviour units and time units by determining what constitutes positive attitudes of teachers to work. These may include prompt reaction to students' problems and queries, prompt marking of tests and assignments, marking of registers and attendance records, up-to-date lesson plans/notes, up-to-date in the knowledge of the subject matter, classroom management etc. You should avoid vague definition of behaviours because they could lead to guesswork.

3.2.1   Types of Observational Variables

According to Borg and Gall (1983), there are three types of observational variables. These are:

(a)   Descriptive or Low Inference Variables:

These variables need little or no inference on the part of the observer. They generally yield reliable data. This is because if there are more than one observers, the level of their agreement in recording the same kind of behaviour is expected to be high e.g. the number of times a teacher comes late to class, the number of questions asked by the teacher in a lesson, the number of assignments given to the class in a week, etc.

(b)   High Inference Variables:

In this case, an observer needs to give an inference before scoring the variable. It is not easy to collect reliable data on such variables. The level of agreement between two observers recording the same behaviour will be low. For instance, if there is an oral interview for the employment of teachers, you will notice the type of self confidence exhibited by the interviewees in answering questions from the interviewers. You will see some answering with a great deal of confidence, some may appear un-sure of themselves, some may appear confused, while others may be nervous. You will note that these are not behaviours, but variables that reflect the different levels of competence of these teachers in the areas of questioning. To this effect, inferences can be made from these behaviours.

(c)   Evaluative Variables:

Here, more than inference is required on the side of the observer. You need to make an evaluative judgement. For instance, if a teacher is making an explanation or description about a statistical concept, while you as an observer, need to rate or score the quality of that explanation. You will notice that quality ratings are not behaviours, but inferences made from behaviours. You will find it difficult to make reliable observations of evaluative variables. What you should do in this case is to collect examples of such

behaviours and define points along a continuum from excellent-to-poor explanations and use it for such ratings.

3.3   Phases of Observational Method

The six phases of systematic observation are given below:

(a)   Definition of Aims and Objectives:

If you want to conduct a systematic observation, you should start by defining the focus of your observation. You cannot observe everything in every situation. You have to decide what to observe by defining the aims and objectives of the observation as derived from your hypotheses and/or research questions. For instance, if the research question is "What instructional aids are used in the introductory technology lesson?" Then you must ignore other aspects of the lesson and focus on the instructional materials. Here, your objective may be to identify the different types used, to count the number of each type used, to record the number of times each type is used, etc. In this case, you will be collecting relevant data for the solution of ht research problem.

(b)   Selection and Definition of Attributes:

At this point, you will need to select and define the target objects and events. For instance, if your focus is on the instructional aids, you have to identify items which would be classified and accepted as instructional aids. Models, drawings, specimens, charts, projectors, machine tools, hand tools, pictures etc. You will also need to define the characteristics of each item to differentiate it from others. For example, what differentiates a machine tool from a hand tool? On the term "used", for instance, if a machine tool is mounted on the floor of the workshop when it is used, if it is referred to, if it is used to explain something? Or if it is manipulate?

It is necessary that these things are clarified to prevent confusion in categorization among different observers or by the same observer at different times, different places or different encounters; it improves the reliability of counting and recording procedure. Abstract qualities such as inquiry, honesty, stress etc. should be well-defined by their denotable characteristics.

(c)   Selection of Observation Modes and Training of Observers:

At this stage, you have to take a decision on the type or mode of observation to adopt. You can decide to use the natural senses or technological gadgets. You can decide to be a participant in the target situation or a non-participant. You have to know which mode is more appropriate for the particular situation before the actual observation.

Your choice of observation mode should be guided by the consideration of having minimum interference can be achieved by the use of one-way screens, remote censors, light differential and elevated corridors. These will keep you out of the views of the

subjects. You can use micro-recorders to make the subjects less conscious of being observed. If you choose to be a participant observer, do not play a leadership role.

(d)   Administrative Arrangements:

For you to carryout a systematic observation, you have to make adequate arrangements and proper planning. These will enable you obtain valid data. If it is in a school situation, you have to seek for the cooperation of the school heads, the teachers, look for and mount appropriate technological gadgets and plan and adopt such strategies that will ensure minimum dislocation of the phenomena under observation.

(e)   Observation:

As much as possible, let your observation focuses on the low-inference and not denotable characteristics or high inference abstract qualities. For instance, if again you want to observe teachers' attitude to work, denotable indicators can be punctuality, regularity, extra hours of work, etc. Attitude is then inferred rather than observed. But there must be an integrated theoretical or empirical basis for the inference.

Consideration should be given to the number of visits or observations needed for reliable observations. You can use as many as thirty visits, though most studies cannot afford more than a dozen observations on a single teacher. In order to obtain a trustworthy mean score for one teacher, particularly for cognitive variables, you need as many observations as possible. You have to gird against observer effects. You have to provide a situation where you can observe without introducing some distortion to the events that would have occurred if observations were not taking place. To minimize distortion effects in observation, possible techniques are: habituation-staging with the participants long before the observations start. This will make the participants not to attach any importance to your presence. Others are assessment of effects and remote presence. You should also guard against halo-effects and interpretation bias during observation.

(f)   Quantification of Observation:

Observations are quantified by coding. There are multiple coding systems in use today. The three major types are the sign system, the category system and the rating system.

(i)   *The Sign System* otherwise called interval recording, records the event once within a specified time period. It does not matter how many times the event occurs during that period. A typical example is the Science Teaching Observation Schedule, STOS (Eggleston, et. al., 1975).

(ii)   *The Category System* which records an event each time it occurs. A typical example is the Biology Teacher Behaviour Inventory, BTBI (Evans, 1869; Balzer, 1969).

(iii) *The Rating System* which estimates the frequency of events only once, usually at the end of the observation session. A typical example is the teaching practice rating.

Other methods like the use of anecdotal records do not usually require quantification. In some arithmetic processes are applied directly to quantitative counts obtained from sign and category system data to yield relevant interpretations. In the rating system, frequency estimate of the events is scaled ordinally. The ordinal scores of all events are totalled. The total scores indicate the level of excellence or otherwise of performance.

Self Assessment Exercise 11.1:

1.   What are the three types of observational variables?
2.   Explain the phases of observation method.

3.4   Recording Observations

You have gone through the variables and the phases of observation. Before we go on to the recording techniques, let us briefly touch on the types of observations.

3.4.1   Types of Observation

In general, there are two types of observation. These are: participant and non-participant observation.

(i)   Participant Observation in which the observer is either a member of the setting or group being observed or has joined the setting or group just for the purpose of carrying out the observation. In this case, the observer is always with the observed e.g. your head of department, the principal and the teachers, the instructor and the apprentice etc.

(ii)   Non-Participant Observation in which the observer is not a member of the setting or the group being observed. The observer visits the observed at different intervals e.g. Supervisors from the Ministry of Education to the schools, or Inspectors from the Inspectorate, Teaching Practice etc.

3.4.2   Techniques for Recording Observations

The techniques as classified by Borg and Gall (1983) are:

(i)   Duration Recording: This involves measuring the length of time in which target behaviour occurs. You may use some form of timing device like the stopwatch. You may record the time for a single behaviour. For example, the length of time a student stays without making noise, the length of time the teacher talks before moving around etc.

(ii) **Frequency Count Recording:** This involves recording the number of times the target behaviour is exhibited by the subject. You may use a tally sheet or a counting device to record each time the behaviour occurs. It is most useful in recording behaviours of short duration, e.g., how many times a student raises his hands to answer a question, how many times a teacher use praise to reinforce a good behaviour etc.

(iii) **Interval Recording:** In this case, the target behaviour is observed at intervals of say 30 seconds or one minute. The length of time varies with the nature of behaviours being observed. For instance, which of the listed mannerisms does a teacher exhibit within the time interval.

(iv) **Continuous Observation:** In this case, all the behaviour of the target subject are recorded in a chronological order during the observation session. For example, recording everything which the subject does in a given setting – playground, classroom, in a meeting etc.

(v) **Time Sampling:** In this case, you will select time intervals out of the total time available for observation. You can only observe during the selected periods. The periods can be selected at random and can be used in conjunction with the other methods. For instance, you can select school days at random in order to observe a given teacher or teachers.

3.5 **Validity and Reliability of Observation**

This will be discussed under the following sub-topics.

3.5.1 Validity

In order to have a higher degree of validity in your observation, you will need to:

(i) Identify those critical incidents of behaviour which are truly significant. In this case, you may wish to supplement your knowledge and skills with the judgement of experts in the field under study. This will help you to select a limited number of observable incidents which are actually related to the behaviours under study.

(ii) Conceal the observer and his intensions. This is because if the observed are aware of the presence of the observer, their behaviour may be influenced. This is a threat to the validity. While some scholars believe that if an observer stays for a long period of time, his presence will be taken for granted and seen as part of the setting with little effect on the behaviours observed. But others feel that if the observer is introduced as active participant in the activities of the group being observed, it will minimize the effects of intrusion.

(iii) Prevent observation bias. This becomes a threat to validity when you are the sole observer and unconsciously see only what you expect to see and to overlook those incidents which do not fit your theory. Your own feelings, values, attitudes and past

experiences may distort your observation. You can use trained observers and restrict your role to the interpretation.

(iv)   Randomly select time sample for observing frequently occurring incidents. This may help to yield more representative samples of behaviour and improve the validity of observation.

3.5.2   Reliability

To determine the reliability of observation, you have to compute the correlation coefficient for the sets of scores from two different observers for a given target groups or subjects at the same time. The reliability of the observation should be determined during the try out or pilot phase of the observation.

3.6   Training Observers

According to Nwana (1981), observational studies are time consuming and require long periods of patiently watching events. Of course, you know that the pace of observational settings is never controlled by the observer. Therefore, you need to employ the services of assistant observers to carryout the observation. But you have to note the advice of Mouly (1978) that observation is not better than the people doing it. Again, the fact that human behaviours are complex, the observer is always faced with determining which factors are significant from a multiplicity of events occurring simultaneously. It becomes particularly important to train the observers.

You should train your observers by defining and explaining the observational variables and how to observe and record them. You should also explain the purpose of observation and familiarize them with the aims and objectives so as to make them appreciate the observation. Explain the recording sheet or form, define clearly and precisely the behaviours to be observed. Use a trial observation in your training.

According to Nwana (1981), the trial observation may be repeated to ensure consistency and agreement amongst the assistants and the investigators' records can be taken as a standard. Where facilities are available for use in the observation, the observer should be trained on how to use them. Recorded behaviours can be shown to the trainees. After the training has been conducted to a desired level of agreement and accuracy, the observation should start without delay that may cause some loss in observer skills.

Self Assessment Exercise 11.2:

(i)   What are the two types of observation?
(ii)   Explain the observation recording techniques.
(iii)   What are the things you should do to have higher degrees of validity in your observation?

3.7   Problems of Observation

Observation, as a method of data collection, has some problems. These are:

(i)   ***Observer Effects***:

These are virtually inevitable, but can be minimized by unobtrusive methods as have been listed under section 3.3 (phases of observation in the unit). Read it again.

(ii)   ***Observation Requires Enterprise***: In order to have proper observation, you need to be trained if you are not an expert. Assistant observers also need to be trained. This will help to save time or maintain objectivity.

(iii)   ***The Number of Observations***: The number of observations needed to obtain a representative sample of events is most of the times prohibitive. This is why many researchers resort to studying the target phenomena shoddily.

(iv)   ***Interpretation Bias***: If a researcher decides to report a coloured version rather than the objective findings, it can distort the observed event. This can be minimized by the use of blind observation whereby trained observers are used without them knowing the objectives of the observation; the use of trained recorders for objective recording of events; the use of multiple independent observers or the use of taped recorders which can allow analysis and re-analysis.

(v)   ***Halo-Effects***: You have read about this in the last unit. In this case, it means later records of observations being affected by earlier impressions. This can reduce the reliability of information collected through observation.

(vi)   ***Rating Errors***: This can occur when the rating system is used. It can be as a result of ambiguities in the meaning of the scale points. Again, rating systems such as the tendency to rate subjects towards the middle, rather than at either of the two extremes.

3.8   Advantages and Disadvantages

The advantages and disadvantages are listed separately below.

3.8.1   Advantages

(i)   It provides unique insights not attained by other methods.

(ii)   It yields direct first-hand information which is more valid than reported information.

(iii)   It is peculiarly suitable for the study of young children, handicapped persons and illiterates.

3.8.2   Disadvantages

(i)   It requires enormous amounts of time, energy and resources to be properly executed.

(ii)   Samples are usually small and this tends to reduce the internal validity as well as the external validity or generalisability of the findings. This is because of the unrepresentativeness of the samples.

(iii)   Some behaviours are not explicit and observation may not apply in such situations.

(iv)   The faking of some participants when they know that they are being observed.

3.8.3   Guide to Good Observation

The guide to good observation is listed below:

(i)   Obtain prior knowledge of the conditions or background of what to observe;

(ii)   Examine the general and specific objectives of the observation;

(iii)   Determine the method of observation – direct, using assistants, participants or non-participant;

(iv)   Define and establish the variables of observation;

(v)   Device an appropriate method of recording results;

(vi)   Observe carefully, critically and objectively;

(vii)   Rate specific phenomena independently, in the case of rating;

(viii)   Do not interfere with the setting in which the observation is taking place.

4.0   CONCLUSION

The observation method of data collection uses systematic procedures to identify target phenomena, to categorise, observe and record them. It can be undertaken using any of the natural senses or technological gadgets. It is preferred when studying children, illiterates, traits that cannot be tested with pen and paper, and phenomena which must be looked at. It may be used alone or in supplement with other methods. In the next unit, you will read about other methods of data collection.

5.0   SUMMARY

In this unit, you have learnt observation is a process of looking out for and recording the presence or absence of a particular trait or behaviour of a person or group of persons. You also looked at the observational variables where you learnt that the three of them are descriptive or low inference variables, high inference variables and evaluative variables. In the phases of observation method, you learnt that they are:

(i)   Definition of aims and objectives;
(ii)   Selection and definition of attributes;
(iii)   Selection of observational modes and training observers;
(iv)   Administrative arrangements;
(v)   Observation, and
(vi)   Quantification of observation.

You also learnt that the two types of observations are participant and non-participant observation. The techniques for recording are:

(i)   Duration recording;
(ii)   Frequency count recording;
(iii)   Interval recording, and
(iv)   Time sampling.

You read about the validity and reliability of observation and how to train observers. The problems of observation are:

(i)   Observers effects;
(ii)   Expertise in observation;
(iii)   Number of observations required;
(iv)   Interpretation bias;
(v)   Halo-effects, and
(vi)   Rating errors.

You also saw the advantages and disadvantages.

6.0   TUTOR MARKED ASSIGNMENT

1. What is observation?
2. What are the phases of observation?
3. Explain the two types of observation.
4. What are the techniques for recording observation?
5. What problems do you have in using observation?

Answer to SAE Question 11.1

The three types of observational variables are: Descriptive or low inference variables, high inference variables and evaluative variables.

The phases are:

(i)   Definition of aims and objectives;
(ii)   Selection and definition of attributes;
(iii)   Selection of observation modes and training of observers;
(iv)   Administrative arrangements;

(v)   Observation, and

(vi)   Quantification of observation.

Answer to SAE Question 11.2

The two types of observation are: participant observation and non-participant observation.

The observation recording techniques are:

(a) Duration recording;
(b) Frequency count recording;
(c) Interval recording; and
(d) Time sampling.

In order to have higher degrees of validity in one's observation, the following should be done:

(i)   Identify the critical incidents of behaviour which are truly significant;

(ii)   Conceal the observer and his intentions;

(iii)   Prevent observers bias; and

(iv)   Randomly select time sample, for observing frequently occurring incidents.

7.0   REFERENCES AND FURTHER READINGS

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UNIT 12   QUESTIONNAIRES

Table of Contents

1.0   INTRODUCTION

In the last unit, you read through observational methods of data collection. The second method of data collection is the use of questionnaire.

In educational research and in most social sciences researches, the questionnaire is the most frequently used instrument for data collection. It is the most popular instrument. This is demonstrated by the number of published studies and students' research projects which employ this instrument of data collection.

In this unit, you will study in details, the questionnaire as an instrument for data collection in educational research.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   define the concept of questionnaire;
(ii)   enumerate the types of questionnaire;
(iii)   construct questionnaire items;
(iv)   explain how to validate a questionnaire;
(v)   list the advantages and disadvantages of questionnaire;

(vi)   discuss the characteristics of a good questionnaire.

3.0   MAIN CONTENT

3.1   The Concept of Questionnaire

In a research situation, a questionnaire can be said to be a carefully designed instrument for collecting information or data in relation to the specifications of the research questions and hypotheses. This instrument is used to elicit written responses from the subjects of the research through a series of questions or statements put together with some specific objectives in mind. It can be used to ascertain facts, opinions, beliefs, attitudes, practices, etc.

Obodo (1997) defines it as a series of questions or statements presented in a written form to a subject or group of subjects and to which they are expected to answer in writing. You can see that it is the most common, used like a test and constructed for specific purposes. It is also used for the assessment of students' personal-social adjustment and interest with regards to different issues. You need to think of a specific study and design before you determine whether it will be appropriate for you to use a questionnaire. For instance, when you require to obtain data on the distribution of a group of subjects in relation to such factors as gender, state of origin, state of residence, qualification, experience on a job, age, socio-economic status or to provide information for assessing certain situations such as the availability of workshop equipment, laboratory facilities, facilities in a state, school, or the extent of implementation of a certain school programme etc. It can be used to obtain information on the feelings and perceptions of a group of people towards certain issues such as the ODL system of education, or the perception of the problems or their attitude towards the problems associated with the use of information and communication technologies in our educational system.

3.1.1   The Components of Questionnaire

A questionnaire is made up of such components as the title, the introduction, the response instructions, biographical information, the questions/statements, return instructions and gratitude. For you, as a student/learner, a letter of reference from an appropriate authority may accompany your questionnaire to elicit the cooperation of your respondents. Now, let us briefly touch on these components.

1.   *The Title*:

This gives an appropriate caption for the substantive content of the questionnaire. It is not the topic of the research project, e.g. Public perception of ODL Questionnaire (PPODLQ), Students' attitude to Physics Practicals Questionnaire (SAPPQ) etc.

2.   *The Introduction*:

This gives the main objectives of the research and/or the questionnaire. It also gives a guarantee of anonymity of the respondents and confidential treatment of the information supplied. It establishes a rapport with the respondents by assuring that no information in

the research report can be traced to particular individuals. This will likely bring out accurate, frank, objective and comprehensive information from the respondents.

3.   *The Response Instruction*:

This specifies the mode or modes of completing the questionnaire. You have to instruct the respondents to fill in the blanks, underline, put a cross, circle or tick the appropriate place. It is a good practice to use one or two questions and answers to illustrate what they should do.

4.   *Biographical Information*:

This gives the personal data of the respondents. It is required for analysis and interpretation of the data. It includes such things as type of school, class, occupation, sex, income, age, qualification, experience, social class, marital status, etc. You should include only the variables that are needed for analysis and interpretations. Again, you have to be cautious on the type of information being elicited or required. For instance, divorced, separated, or widowed, instead of asking for exact age, give age range, when information is sought what social class, income occupation, qualification, etc. respondents may be prestige-biased and therefore predisposed to overclaim, thus introducing response error.

5.   *The Questions/Statements*:

This gives the actual substantive content of the research. They can require factual answers, opinions or evaluations. Every question/statement has to address a specific issue in the research. Therefore, the questions/statements must not be written aimlessly, haphazardly or shoddily.

All the statements or questions must be relevant to the hypotheses and/or research questions. Do not add unnecessary questions to make the questionnaire lengthy. Select words which will give you the required information with a minimum of distortions. The language should be simple, clear and precise. You must try to avoid ambiguous, suggestive, leading, antagonistic and embarrassing questions that invade privacy. Do not use double-barreled questions.

6.   *Return Instructions*:

These direct the respondents on what to do with the completed instrument. Specify the collection point, a mailing address or to hand them back to you or your assistants.

7.   *The Gratitude*:

This is the end of the instrument. You should recognize that the respondents are under no obligation to complete the instrument. In fact, they are doing you a favour. Therefore, you need to appreciate the respondents by thanking them.

3.2   Types of Questionnaire

Based on the format for the statements/questions and the responses, questionnaires can be classified into two major types. These are structured/closed or fixed response type and the unstructured/open end type. Let us look at them.

3.2.1   The Structure or Fixed Response Questionnaire

Here, the respondents are restricted to some response options. A question is asked or a statement is made and a respondent has to choose from the available alternatives. You can see that the respondents do not have the freedom and opportunity to express their views. Look at some sample items of the fixed response type below:

(a)   How old are you?
    20 – 30 years   (   )
    31 – 40 years   (   )
    41 – 50 years   (   )
    51 – 60 years   (   )
    61 and above   (   )

(b)   For how long have you been teaching?
    Below 5 years   (   )
    6 – 10 years   (   )
    11 – 15 years   (   )
    16 – 20 years   (   )
    21 and above   (   )

(c)   What is your highest qualification?
    T.C. II   (   )
    N.C.E.   (   )
    B. Ed.   (   )
    M. Ed.   (   )
    Ph. D   (   )

This type of questionnaire is usually preferred because it facilitates data analysis and the estimation of validity and reliability indices for the instrument. Again, it is easier and demands less time to complete. But on the other hand, a respondent may have different suggestions for your imagination. He may not have the opportunity to give those suggestions.

3.2.2   Unstructured or Open-Ended Questionnaire

Here, response options are not provided for the respondents. All you need do is to provide questions pertinent to the problem and the respondents are free to supply their responses in their own words and in any manner they deem fit. When you are not sure or cannot predict what the subjects' responses are likely to be, this type of questionnaire is the most appropriate. See sample items below:

(a)   Do you have open and distance education in your state or country? ………………………

(b)   How is it operated? …………………………………………………………………………...

(c)   Would you say it has advantages over the conventional system of education? ……………
        ……………………………………………………………………………………………………

(d)   Why do you say so? …………………………………………………………………………..

The open-end questionnaire can provide unanticipated and insightful information that could lead to a better understanding of the problem. But they are difficult to complete and time-consuming. There may be misinterpretation arising from the fact that some people may not be able to express themselves very well; while others may use styles which are at variance with that of the researcher. These may bring about communication problems. Again, classification and quantification of the responses are very difficult leading to serious difficulties in the data analysis.

Self Assessment Exercise 12.1:

(i)   What is a questionnaire?
(ii)   Explain the components of a questionnaire.
(iii)   Discuss the two types of questionnaire.

3.3   Construction of Questionnaire Items

For you to construct a questionnaire, you need to clearly identify the objectives for which the questionnaire is expected to accomplish. This will make the questionnaire to yield information pertinent to the problem of study. After identifying the objectives, you then start to construct the items. To be able to write good questionnaire items, you have to consider such factors like: the sample characteristics, type of questionnaire format to adopt and the length of the questionnaire.

(a)   *The Sample Characteristics*: Here, you may need to know the educational level, their socio-economic class, age etc. Why do you have to know this information about your samples? This will enable you keep the language and illustrations at such a level that will be appropriate to the samples.

(b)   *Type of Questionnaire Format to Adopt*: You have to decide whether to use the restricted response format or the open-end format. This will depend on the type of data you need to generate and the type of analysis you require to do.

(c)   *The Length of the Questionnaire*: You have to put into consideration that the longer the instrument, the higher the reliability. But it can be boring to complete a lengthy instrument. Therefore, you will have to construct an instrument which is neither too short nor too long.

When you are constructing a questionnaire, you have to note:

(i)   It is not good to include items which have no relationship with the research objectives. This is time and effort wasting and tends to unduly increase the length of the instrument without any added advantages.

(ii)   Avoid unnecessary presumptions. Take for instance, a study on parents' supervision of their children's home-study, a question was asked thus: "How often do you supervise your child's home-study?" You can see that this question is presumptuous, in that it presumes that the respondent has a child and again that he supervises his child's home-study.

Instead, you can start by asking:

(1) Do you have a child?
(2) If your answer is yes, do you supervise his home studies?
(3) If so, how often do you do this? etc.

(iii)   Avoid leading questions. For instance, look at this item. For the fact that open and distance learning is flexible and affordable, don't you think it can be encouraged in this country? Instead say: What do you think about open and distance learning?

(iv)   Always note the distinction between "what ought to be" and "what is". For instance, if you ask a teacher – "Do you supervise your students when doing practical work in the workshop?" This question relates to what is, because it is your duty to supervise and that's exactly what you do. But if the question is "Should you supervise your students during their practical work in the workshop?" This is what ought to be.

3.4   Validation and Pilot Testing of the Questionnaire

Validation of an instrument is done in order to ensure that the instrument has validity. It is a serious limitation which is inexcusable in scientific research if a questionnaire is used without proper validation exercises. The simplest method of validating an instrument is to subject it to expert validation.

In this method, you will make copies of the instrument and give them to a panel of experts in the area. You will also write a covering letter to these experts stating what you need them to do. This letter should contain a clear, guideline of what they are expected to do, the purpose of ht research, the research questions and/or hypotheses. You should also instruct the experts to review the items in terms of their clarity, appropriateness of the language and expressions to the respondents and the instructions too. You will also provide space for the experts to make any other comments regarding the overall adequacy of the instrument. When the instrument is returned, you will carryout the modifications along the lines suggested by the comments of these experts. This validation exercise will ensure both the face and content validity of the instrument.

The next stage is to subject the instrument to trial or pilot testing. This involves administering the instrument on a very small sample of those whom it would be used in the final study, under similar conditions. This will enable you to see how the subjects will react to the instrument,

whether the questions are clear and easy to understand, whether more items are needed in certain areas and whether there are items which the respondents cannot react to. It will also help you to determine whether the methods of data analysis proposed for the final study are appropriate.

3.5   Administration of Questionnaire

Administration of the questionnaire to the respondents can be done in any of these three ways:

(1)   By Mail: In this case, the questionnaire is sent by mail to the respondents who are expected to complete and also return through the post. If you want to use this method, then you have to encourage a high response and return rate by enclosing stamped self-addressed envelopes for the return. Some of the times, you need to send appropriate, tangible inducements such as gifts or suitably-worded and non-threatening reminders to those who have not returned by due time. You should also make arrangements for substitute respondents where possible. The advantage of using the mail is that suitably qualified respondents can be used in the research while they are very far away. Again, the respondents can afford to consult sources of information. It can also increase the chances of obtaining valid but socially unacceptable responses. Again time and travelling expenses are conserved. The advantages are:

(i)   Very poor response or low percentage returns which tend to reduce the sample size and leads to sampling bias;

(ii)   Not suitable for persons of low intelligence or low educational background, since you are not there to explain any misinterpretation;

(iii)   The instrument may be given to a more competent person to fill i. this may result in the distortion of the sample and results;

(iv)   You cannot follow any chronogram, since you do not have control of the time to receive the responses and therefore plan to start the analysis;

(v)   You cannot guarantee the return of the instrument by post, especially in Nigeria where the postal services are very poor.

(2)   Personal Administration with on-the-spot collection: In this case, you and your research assistants can deliver the questionnaires to the respondents in person, wait for them to complete and collect them back. This method can give you a 100% delivery and return. It will also provide the opportunity to clarify misinterpretations, while ambiguities are kept to a minimum. You are also in control of the time for completing the project. But if the respondents do have the answers on-the-spot, he may need to access the information before completing the questionnaire.

Again, your presence may influence the respondents to fake responses or put them under psychological tension. The personality of the researcher may positively or negatively affect the diligent completion of the instrument.

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(3)   **Personal delivery with collection after a time interval:** In this case, you need to deliver the questionnaires in person, but return after some time to collect them. This mode affords the respondents time to look up information. They are more relaxed while completing the instrument. Therefore, it is preferred when documents and other sources need to be consulted. But you may not be sure of 100% return. Again, time and money may be wasted in repeated trips to check on the respondents. There may be mass consultation of respondents in close proximity in your absence. This may give rise to uniform responses which will reduce the validity of the data. Note that these modes may be used in combinations. It depends on your choice.

Self Assessment Exercise 12.2:

1.   What are the three things you must bear in mind when constructing a questionnaire?
2.   Explain the three types of questionnaire administration.

3.6   Characteristics of a Good Questionnaire

You have seen that the questionnaire is a very popular method of data collection in education and behavioural sciences. The reason can be attributed to the relative ease and cost-effectiveness with which it is constructed and administered to large samples when compared to other methods. To serve its purposes very effectively, the questionnaire you construct must be characterized by the following features:

(i)   **Relevance**: The instrument should be relevant to the purpose of the research. It should elicit all the information necessary for answering the research questions and testing the hypotheses. It should also consider the background and experience of the respondents.

(ii)   **Consistency**: The instrument should be able to yield responses that are consistent. The responses of a group of people to the instrument on two different occasions should be as close as possible on these occasions.

(iii)   **Usability**: The instrument should as much as possible be usable. It should noe be too long or so bulky. The conditions for the administration and the method for interpreting the data elicited should be fairly simple and easy.

(iv)   **Clarity**: Both the instructions and the items should be clear enough to avoid possible misinterpretations. You should note once again that a good questionnaire should not contain ambiguous items or instructions.

(v)   **Quantifiability**: The responses from a good questionnaire must be easily quantifiable. It should be easy to assign numerical values or figures to such responses in a manner that is systematic.

(vi)   **Legibility**: All the items should be legible without tiny characters. The words should be properly spaced with appropriate side margins. Always use the computer to type your questionnaire so as to produce very neat and legible instrument.

3.7 Advantages and Disadvantages

You have noticed that in every section of this unit, one or more advantages or disadvantages may have been mentioned. Let us now summarise them briefly.

3.7.1 Advantages

i.   It is economical in terms of time and cost;

ii.   It can be administered to variety of people;

iii.   It is easy to administer and even to distant respondents;

iv.   It can be used to get information on non-cognitive constructs such as kindness, stress, anxiety etc;

v.   Great percentage of students or respondents can be reached at a time.

3.7.2 Disadvantages

i.   There may be low percentage return which may lead to the distortion of the findings;

ii.   There may be misunderstanding or wrong responses if the item s are not clear or the instructions are misleading;

iii.   Wrong or negative or faked answers may be given if the instrument is too lengthy or if it is intruding o the respondents' private life;

iv.   It is not suitable for the illiterates, semi-illiterates, and children.

Self Assessment Exercise 12.3:

What are the characteristics of a good questionnaire?

4.0 CONCLUSION

In this unit, you have learnt that the questionnaire is a carefully designed instrument for collecting data in accordance with specifications of research questions or hypotheses. You have worked through the construction, validation, administration etc. of the questionnaire. As the most popular method of data collection, you may find it useful in your research project. In the next units, you will be seeing other methods too.

5.0 SUMMARY

In this unit, you learnt that a questionnaire is a series of questions/statements presented in a written form to a subject or group of subjects and to which they are expected to answer in

writing. You studied the components which include: title, introduction, instructions, biographical information, the items, return instructions and the gratitude. There are two main types of questionnaire. These are the structured or fixed response and the unstructured or open end questionnaire. You have worked through construction of questionnaires and the consideration to be made in order to construct the questionnaire. Validation of an instrument is done to ensure the validity of the instrument. The simplest method is the expert validity, consistency, usability, clarity, quantifiability and legibility. Questionnaires can be administered by mail, personal administration with on-the-spot collection and personal delivery with collection after a time interval.

6.0   TUTOR MARKED ASSIGNMENT

1. What are the components you will have in a questionnaire?
2. With examples, explain the two types of questionnaire.
3. What are the characteristics of a good questionnaire?

Answer to SAE Question 12.1

A questionnaire is a series of questions/statements presented in a written form to a subject or group of subjects and to which they are expected to answer in writing.

The components of a questionnaire include: the title, the introduction, the instruction, biographical information, the items, return instruction and the gratitude.

The two types of questionnaires are the structured or fixed response type and the unstructured or open end type.

Answer to SAE Question 12.2

The three things are: the sample characteristics, the type of questionnaire format to adopt, and the length of the questionnaire.

Administration of questionnaires can be done by mail, personal administration with on-the-spot collection and personal delivery with collection after a time interval.

Answer to SAE Question 12.3

The characteristics of a good questionnaire are: relevance, consistency, usability, clarity, quantifiability and legibility.

7.0   REFERENCES AND FURTHER READINGS

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UNIT 13   INTERVIEWS

Table of Contents

1.0   INTRODUCTION

In the last two units, you studied the observation and questionnaire techniques for data collection in research. In this unit, you will see that for some categories of people you will need the interview method in order to collect information from them. Interviews with the subjects are valuable data collection tools particularly when the subjects cannot read and write or are too young or too old to read. Interview gives you the flexibility which the written questionnaire cannot afford. It is this flexibility that will enable you to collect more useful information than you may have set out to collect. This unit will expose you to the details of how to use the interview technique as a data collection tool.

2.0   OBJECTIVES

At the end of this unit, you will be able to:

(i)   explain the meaning of interview;
(ii)   discuss the phases of interview;
(iii)   list and explain the types of interview;
(iv)   enumerate the advantages and disadvantages;

(v)   discuss the major considerations in an interview method;
(vi)   explain how to record interview responses.

3.0   MAIN CONTENT

3.1   Interview as a technique of Data Collection

The interview as a method for data collection involves eliciting information through some verbal interaction between the respondents and the researcher. In other words, an interview can be regarded as a face-to-face interaction in which oral questions are posed by an interviewer to draw out responses from the interviewee. When we talk about the interaction, we mean that the interviewer, the interviewee and the interview situation or schedule have roles to play. Sometimes interviews can be through telephones.

So if you want to achieve maximum success in your use of interview, the interview situation should be kept as comfortable and permissive as possible. A lot of communication skill is needed in order to frame the questions in such a way that the respondents can understand what information they are required to give. Therefore, you must ask questions which are relevant and related to the type of information you desire to obtain.

3.2   Phases of Interview

There are four major phases of interview. These phases overlap and interact. They are preparation, establishment of rapport, the question-answer and the recording phases.

3.2.1   Preparation Phase

The degree of success in an interview is dependent on how well you have prepared for it. The preparation stage is when you take decisions on the mode of recording the responses. You need to check the recording instruments for validity and reliability. You need to trial-test the instruments to ensure that they are in good working conditions.

For instance, if you are going to use a tape recorder, you have to see that the batteries are good and tried out. If you need to use gifts to express gratitude or to establish rapport, you need to make the correct selection.

Again, during this stage, you will ascertain the cultural background of your subjects, so that appropriate salutations may be used, appreciate wears may be selected in advance. You also need to ascertain the biographical data of your subjects so as to address them appropriately. Your questions should be derived from well-defined hypotheses or research questions. They have to be edited in terms of such issues as appropriateness, length, relevance, palatability, clarity, simplicity, precision, language and the conceptual levels. You have to validate the questions. You remember how the questionnaire instruments were validated?

It is the same thing here i.e. through expert validation and trial-testing. After the validation, you would review the questions thoroughly, memorise them, if possible and rehearse it to mastery level in the sequence in which they will be asked.

3.2.2 Rapport Phase

For you to collect valid data, you need to establish a cordial atmosphere for the interview. There is no rule for doing this, but as a mature investigator, you have to survey the situation and evolve appropriate strategies. You may follow any of these suggestions:

(i)   Courteously seek permission from the appropriate authority. In doing this, you should provide information about the objectives of the study and the nature of the interview.

(ii)   Give notice to the interviewee and book appointment for date, time and venue. The venue should be comfortable in terms of sitting, ventilation, lighting and decoration. The venue should be noise-proof.

(iii)   Take note of your appearance. It should be appropriate, neat, unoffensive. Consider your dental and body deodorization and any other aspect likely to irritate your subject.

(iv)   Your first contact with the interviewee must be friendly, pleasant and courteous. Use appropriate salutation and address him with the correct title. Pay some compliments, but not flatter. This will make him more relaxed.

(v)   You need to be relaxed too. Introduce yourself briefly and modestly and also introduce the problem which is the focus of the interview. You may need to start by asking the first few minutes for a short conversation to enable you and your subject to relax. You also need to assure him that his responses will be treated confidentially and only for the research purposes. Otherwise, he might be suspicious and unwilling to respond to the questions freely.

3.2.3 Question-Answer Phase

This is where you have to make use of your skills and expertise to make the session more permissive, flexible and interactive. You have to keep the interviewee, interested and responsive till the end of the interview.

In doing this, you have to devise appropriate strategies, but you have to be pointed and business-like and not to wonder aimlessly. When you ask a starter question, follow it up with prodding and probing questions to get comprehensive information. Where you need to use pictures or related objects, drafts, drawings etc. use them for probing to elicit further explanations and reasons for earlier statements. But you should try to avoid interviewer bias by being as non-directive as possible. In all, you have to be relaxed, not tensed up or nervous throughout the duration of the interview.

3.2.4 Recording Phase

Recording is a very important aspect of interview. You must try to comprehensively record information from an interview as unobtrusively as possible. Recording may be done in any of the three methods.

(a) *Mental Note*:

If you want to commit the responses into memory, you can be sure; it removes apprehension on the part of the respondent and therefore increases the rapport. But you have to appropriately assess yourself in terms of memory retention before using mental notes. This is because any information forgotten is as good as missing and may not be easily reconstructed.

(b) *Written Note*:

It is advisable to use written records when there are too many questions and responses. But extensive writing is likely to excite or offend respondents. If this happens the rapport and validity of the responses will be reduced. If you are versed in shorthand, it can be an advantage in written notes. You can also use structure interview schedule where alternative responses are provided. Here, there is minimum writing, but you have to make allowance for unanticipated responses.

(c) *Taped Records*:

In order to solve all the problems of memory loss and that of extensive writing, tape recording of interview is the answer. It removes strain from the interviewer. It can be replayed and transcribed at leisure. But you have to bear at the back of your mind that audio and video recording instruments can go faulty in the process. You must take care of this at the planning stage. Other problems like instrument reactivity should also be taken care of. Recording can also frighten or excite the subject. This may channel away his attention and bring about distortion in his behaviour. As far as possible, conceal your recorders. You can use micro recorders, remote censors or pick up buttons when available.

Self Assessment Exercise 13.1:

(i) Explain the phases of interview.
(ii) What are the three main types of recording interview?

3.3 Types of Interview

There are basically two types of interview. These are the face-to-face interview and the telephone interview. You have to note that whether it is face-to-face of telephone interview you are using, they have the same characteristics. Interaction between the interviewer and the interviewee is purely verbal. The responses are recorded by the researcher himself. In this case, you can be sure of the accuracy of the information recorded and the difficulty of decoding some recorded information is removed. Again, there is a great deal of flexibility in the interview technique. The only difference between face-to-face and telephone interview is that in telephone

interview no one sees the other. The advantages of the telephone interview are that it is cheaper, especially if the respondents are very far away, and the interviewee is shielded from the influence of the interviewer. Interviews can also be structured or unstructured.

3.4 Advantages and Disadvantages

From the foregoing discussions, you can see that the interview provides a very useful and powerful means of collecting data on significant educational problems. Of course, you know that there are instances where only the interview can be used in data collection. Let us summarise the advantages and disadvantages below.

3.4.1 Advantages

(i)   It provides opportunity for face-to-face interaction.

(ii)   The subjects can respond to questions the way they like.

(iii)   Indepth information which the respondents may not wish to write down can be obtained.

(iv)   Information recorded is reliable because it is recorded by the researcher himself.

(v)   It is very useful for collecting data from children and illiterates or those who cannot fill the questionnaire.

3.4.2 Disadvantages

(i)   It can be very expensive to conduct.

(ii)   It consumes a lot of time.

(iii)   Subjective information derived from unstructured interview may prove difficult to analyse.

(iv)   The validity of verbal responses collected may be questionable.

(v)   Conducting interviews demands a lot of skills.

(vi)   Intra and inter-interviewer variabilities can affect the results. For instance, the mood of the interviewer-fatigue, hunger or other types of pressure on the interviewer (intra-interviewer) or two different interviewers getting different results in a single study (inter-interviewer).

3.5 Major Considerations in Interview Method

There are three main factors, according to Black and Champion (1976), which must be put into consideration in the execution of interviews. Although, we have touched on them while progressing in this unit, we want to emphasise on them in this section. These three factors are interviewer characteristics. Interviewee characteristics and the nature of the problem under investigation.

3.5.1 Interviewer Characteristics

As an interviewer, your characteristics can have profound influence on the success of the interview. For instance, if you are inquisitive, articulate or you have the ability to identify new areas worthy of exploration, these are very important for a successful interview. Also important are the age, gender, cultural affiliation, mode of dressing, status and manner of speech.

These factors, including the interviewers' willingness to be interviewed may help to determine what roles you can play during the interview. You can therefore see that consideration has to be given to the interviewer characteristics and their possible effects on the quality and quantity of information to be obtained.

3.5.2 Interviewee's Characteristics

Most of the times, the characteristics exhibited by the interviewee influence the success of the interview. For instance, an interviewee is expected to communicate verbally his response or feeling in a way that is easy to understand and sensibly too. But when you have very young children and mentally retarded people who cannot articulate their feelings and thoughts properly, interview cannot be suitable. Some other characteristics include level of formal education received by the individual, willingness of the individual to participate etc. If some subjects refuse to be interviewed, you go ahead, interview those who are willing and then use persuasion or any means available involving use of gifts etc. to get them to be interviewed as their not being interviewed will definitely affect the result of the study.

3.5.3 Nature of the Problem

You know that some topics or problems that bother on the private lives of some individuals. Secret or confidential issues cannot be fully investigated using the interviews. Of course, you know that most people would not want to volunteer information freely on those areas. When they do, they may not be frank with their responses. Take for instance, would you, yourself, agree openly to say how many times you have been involved in examination malpractices; your sex life, or your role in the destruction of school property. As a teacher, would you have the courage to tell your students that you failed some courses in your school days? Most teachers claim they were coming first in their classes. You see, what some people may consider as private, sensitive or confidential, others may not see it that way. So you have to devise a means of contending with both parties in your interview.

Self Assessment Exercise 13.2:

Explain the three major considerations in an interview.

3.6 Recording Interview Responses

A very important task you face when you conduct an interview is that of recording the responses. If you fail to record the responses or fail to record them correctly, the entire exercise is invalidated. This is why you have to adopt an effective and suitable recording procedure and to be careful in doing these important tasks. You have been told in section 3.2.4 that there are three

methods of recording responses. You can now turn to section 3.2.4 of this unit and read it thoroughly.

4.0 CONCLUSION

From this unit, you can see that interview involves a verbal interaction between the interviewer and the interviewee. But a great deal of skill in communication is necessary on the part of the interviewer. It is not only a matter of conversing or talking to someone. You have to be skilled in asking the right question in order to elicit the right information from the respondents. Remember to avoid the use of technical jargons otherwise; you will need to explain them to your respondents.

5.0 SUMMARY

In this unit, you have been able to see interview as a face-to-face interaction in which oral questions are posed by an interviewer to draw out responses from the interviewee. You have seen the phases of interview as preparation phase, rapport phase, question and answer phase and recording phase. You also read the advantages and disadvantages of interview, the major considerations, which are interviewer characteristics and nature of the problem. In the next unit, we shall look at some other techniques for data collection in research.

6.0 TUTOR MARKED ASSIGNMENT

(i)   Explain the three types of recording interview responses.
(ii)   What are the three major considerations in an interview?
(iii) What are the main types of interview?

Answer to SAE Question 13.1

The phases of interview which the students should explain are:

(i) Preparation phase;
(ii) Rapport phase;
(iii)Question and answer phase;
(iv)Recording phase.

The three main types of recording are:

(i) Mental note;
(ii) Written note;
(iii)Taped records.

Answer to SAE Question 13.2

The three major considerations in an interview (the students should explain) are:

(i) Interviewer characteristics;

(ii) Interviewee characteristics; and

(iii)The nature of the problem.

7.0   REFERENCES AND FURTHER READINGS

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UNIT 14   OTHER METHODS OF COLLECTING DATA

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1.0   INTRODUCTION

In the preceding units, you have been learning the various techniques of collecting data. From your knowledge of Measurement and Evaluation (EDU 426), you know that your interest in measuring performance is based on making inferences about the skills that underlie it, your interest in measuring recall is based on making inferences about the knowledge acquisitions that underlie it. Therefore, your interest in measuring behaviour should be based on making inferences about the personal attributes that underlie it and your interest in measuring attitudes should also be based or be concerned with the feelings that underlie them.

In this unit, we shall continue our discussions on the techniques of data collection by focusing on the measurement of attitudes and behaviours. We shall also touch on tests briefly because you have already studied it in your Measurement and Evaluation.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain the use of rating scale in measuring behaviour;
(ii)   discuss the types of attitude scales;
(iii)   describe the use of interest inventories in data collection;
(iv)   explain sociometric technique of data collection;
(v)   list the types of tests.

3.0   MAIN CONTENT

3.1   Rating Scales

You have learnt about measuring what students/learners know, how they perform, their achievement, how they think, feel etc. in the various courses you are doing. You can see that all of these and more are important goals of education. But now, we are talking about the students'/ learners' class behaviour. Look at these questions. Do you think that classroom behaviours and personal attributes are relevant and important educational goals? Should you, as teachers, be concerned about them? You answers must surely be yes.

A part of education is developing the kind of personal attributes that enable an individual to behave in a constructive manner, not in an automatic robot-like way, but in a way that reflects concern and consideration for others, self-discipline, morality, drive, and other qualities generally considered desirable.

Now, based on your experience, do you think teachers evaluate students/learners behaviours and personal attributes? Well if we are interested in developing the desired behaviours in our students/learners, it makes sense to determine whether and to what extent these behaviours are being formed. Human behaviour cannot be observed precisely. This is why researchers develop rating scales for use in discriminating human behaviour into categories or levels to give an appropriate indication of where the observed behaviour falls. For instance, a researcher may develop a scale of 3-points, 4-points, 5-points etc.

Example 1:

Academic ability (<u>high   average   low</u>). It can be any number of points depending on what you are looking for. E.g. honesty, very honest 1……………. 2………….….. 3…………….. 4……………….. 5………………very dishonest.

Now look at these examples from Tuckman (1975).

PUBLIC SCHOOLS MATURITY INDEX
NAME …………………………………………………………………….
ADDRESS …………………………………………………………………..
DATE OF BIRTH …………………….. DATE ……………………….

Teacher's Signature	Reliability	Work Habit	Self-Control	Initiative	Sensitivity	Punctuality
Pupils' Estimate						

Score: 4 = Exceptional   3 = Above average   2 = Average   1 = Below average

Example 2:   Classroom Behaviour Rating Scale:

Name of Child …………………………………………..
Name of Teacher …………………………………………...

1. To what extent can be the child's behaviour be described as curious?

    Note at all Curious   1 2 3 4 5 6 7 8 9   Extremely Curious

2. To what extent can the child's behaviour be described as interesting?

    Note at all Interesting   1 2 3 4 5 6 7 8 9   Extremely Interesting

3. To what extent can the child's behaviour be described as Hostile?

    Note at all Hostile   1 2 3 4 5 6 7 8 9   Extremely Hostile

4. To what extent can the child's behaviour be described as Happy?

    Note at all Happy   1 2 3 4 5 6 7 8 9   Extremely Happy

Example 3:   Students Self-Discipline Scale

	Degree of Occurrence		
Students	Behaviour absent		Behaviour present
Worked on a task without the teachers presence	1 2 3	4 5 6	7 8 9
Moved to new task without the teachers intervention	1 2 3	4 5 6	7 8 9
Made adequate evaluation of the quality of work	1 2 3	4 5 6	7 8 9
Made adequate evaluation of the completeness of work	1 2 3	4 5 6	7 8 9
Organized his work schedule as required	1 2 3	4 5 6	7 8 9
Did not treat others violently	1 2 3	4 5 6	7 8 9
Did not attempt to interfere with others work	1 2 3	4 5 6	7 8 9
Maintained work areas	1 2 3	4 5 6	7 8 9

3.2   Attitude Scales

Let us start this section by saying that attitude is a response pattern or a tendency to think or act in a particular way under a given set of circumstances. It is closely related to feelings and emotions which constitute an important aspect of an individual's personality. We can use an attitude scale to measure attitudes towards the introduction of new changes in school, society, system etc. For instance, we can construct attitude scales to measure the attitude of teachers or students/learners towards new educational programme, new punishment mode, new school uniforms etc.

Before we go to some examples of the scale, let us define scale as "a continuum marked off into numerical units that can be applied to some objects or state in order to measure a particular

properly of it. Attitudes and beliefs are typically measured by the use of scales. You see, these are intangible things, unlike weight, height, length etc. where you can objectively use the spring balance, the scale rule etc. The scale used in measuring values, attitudes etc. are subjective and lack precision. The results cannot be exact. They are used extensively in education and social sciences. The three major types are the Likert-type, the Thurnstone scale and the Guttmann scale. Let us look at them.

3.2.1   The Likert-type Rating Scale or Summated Scale

This scale was named after the person who devised it – Rensis Likert. It involves a list of questions or statements about the phenomenon to be measured, with a set of graduated response options. An individual is expected to indicate his degree of agreement or disagreement with the statements or questions. Likert scale is a five point scale. But today there are scales that have less than five points. These are Likert-like scales

The responses to the statements are then summed up and a total score or the average score is obtained. This will help to determine the people's position on the phenomenon which is measured. For example, "I like Geography".

| ☐ | Strongly Agree | ☐ | Agree | ☐ | Disagree | ☐ | Strong Disagree |
| 4 | | 3 | | 2 | | 1 | |

A positive statement attracts higher value while negative statement attracts lower value, e.g. "I do not like Geography".

| ☐ | Strongly Agree | ☐ | Agree | ☐ | Disagree | ☐ | Strong Disagree |
| 1 | | 2 | | 3 | | 4 | |

Sometimes, other terms may be used in the place of agree and disagree, as the case demands. Such examples can be:

Very satisfied, Satisfied, Moderately Satisfied, Dissatisfied
Very important, Important, Somehow important, Not important
Outstanding, Very good, Good, Satisfactory, Poor.

3.2.2   The Thurston Scale or Equal Appearing Interval Scale

This differs from the Likert scale because it has a laid down principle. To use the scale, you will first of all construct a set of more than 100 items which will measure the attribute you want. These items will then be presented to a panel of about 25 judges. These judges will be required to rate each item on the set, according to the degree of intensity, on a seven-point scale or more.

Using the averages of the ratings given to the items by the judges, a numerical value is computed for each item. The items are selected in such a way that they cover the entire scale with equal

intervals between any two consecutive items. You see why it is not very popular in educational researches.

3.2.3 The Guttmann Scale or Cummulative Scale

Unlike the Likert and Thurnstone scales, the Guttmann scale determines the unidimensionality of the items making up a given scale. You may be wondering what unidimensionality means here. For the purpose of this discourse, it refers to whether all the items measure all aspect of the particular variable in question; or just one aspect of it. Let us use computer literacy for example. If you are conducting a study on the attitude towards computer literacy, you will note that there are different dimensions of computer literacy. These may include attitude towards excel, words, powerpoint, internet, search engines, computer science, softwares etc. A subject may have positive attitude towards internet browsing but not MS words. Another may like powerpoint but not excel. Therefore, any two individuals that have the same score using this scale must have expressed similar pattern of interest towards the items in question. In other words, they may have had interest in the same dimension of the variable. When the items on a scale are unidimensional, we say they form a perfect scale. When the items of a perfect scale vary in intensity, the scale is said to be perfectly reproducible. But, when there are errors or inconsistencies in the responses or when we have errors in the scale, the scale is said not to be reproducible. You must have to note that it is difficult to come across a perfect reproducible scale. Guttmann produced a formula which can be used to estimate the extent of reproducibility of a scale. It is called coefficient of reproducibility and it is given by the equation:

$$\text{Coefficient of reproducibility} = 1 - \frac{\text{Number of errors}}{\text{Number of responses}}$$

If the coefficient of reproducibility resulting from the use of this formula is 0.90 and above, we say the scale is reproducible. If otherwise, the scale is not reproducible.

Self Assessment Exercise 14.1:

Identify a research problem where an attitude scale or a rating scale could be used for data collection. Construct a 5-item instrument for the purpose of data collection.

3.3 Interest Inventories

Interests are the likes and dislikes of a person. Then, an interest inventory is an instrument used for measuring the person's likes and dislikes and aversions. A person's interest in an activity, event, object, programme, course etc. is measured with an interest inventory. This consists of series of questions relating to an area of interest. These questions are designed in such a way as to bring out the individual's interest area. The responses to the questions are scored to determine whether or not the individual is interested in the area. A high score shows interest while a low score indicates lack of interest in that particular area.

Let us take for instance that you want to know the occupational interests or aspirations of your students. You may design an interest inventory such as this:

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(i)	Teaching People ……………………….. L I D	L	=	Like
(ii)	Defending people in the court …………. L I D	I	=	Indifferent
(iii)	Treating sick people …………………….. L I D	D	=	Dislike
(iv)	Defending the country …………………. L I D			
(v)	Repairing automobiles …………………... L I D			
(vi)	Maintaining law and order ……………… L I D			
(vii)	Drawing houses …………………………. L I D			

The individual circles round the option he likes. Interest inventories can be constructed in several ways. You can also adapt any of the standardized interest inventories such as Strong Vocational Interest Blank (SVIB), Kuder Preference Records etc. You can modify them for your local use. You will have to note that interests are not abilities. Interests change, especially for young people below the age of 18 years. Therefore, any information on interest should be seen as provisional or valid only for he time it is collected. So any predictions made on the basis of interest should be done with caution.

3.4 Sociometric Technique

This is a technique used for measuring the social structure of a group. It is used for the assessment of the social status of each individual with regards to other members in a group. It can be used to show the pattern of social relationships in a group of people. According to Onuche and Akeju (1988), it is an instrument that is aimed at evaluating the pattern or finding out the extent to which a pupil is accepted by his peers in a given situation. This is why sociometric technique is called peer-at-appraisal method. It can be used to determine the most popular members of the group. You can decide to ask your students to write in a piece of paper. Who they like best or who they would want to work within their group. The result will tell you how popular each member of the group

3.5 Tests

In such courses as Measurement and Evaluation and continuous assessment, test as a subject has been fully discussed. If you have not done them, you will do those courses very soon. In this section, we shall only touch briefly on tests as an important tool for data collection in research.

Tests are specialised instruments for the measurement of mental/cognitive abilities, physical/psychomotor abilities and emotional/affective tracts. Tests are regarded as the most objective measure of a sample behaviour in research. There are different types of tests. These are divided into two broad categories of norm-referenced and criterion-referenced tests.

3.5.1 Norm-Referenced Tests

These refer to tests given to individuals in order to compare their scores to those of other individuals or groups called a norm group. Most of the tests here are standardized and are used at the state and national levels. The Common Entrance Examination for selection of students into post-primary schools are typical examples.

You see that NECO conducts its own entrance examination for the Unity Schools in the country, while all the states have their own entrance examinations. The type of tests used is the norm-referenced tests. You can give other examples like UME, etc.

3.5.2 Criterion-Referenced Tests

These are tests designed to measure some specified behaviour on a criterion that has comparison with any normative or referenced group. You want to see how much of the specified subject matter your students have mastered. You want to see how much of the objectives your students have achieved. In this case, you are free to construct your own test or use a standardized test. If you make your own test, you have to conduct a trial test of the instrument on subjects similar but not those to be used in the research to avoid test-wiseness. The trial-testing or pilot-testing of the instrument will help yo0u to ensure the validity and reliability of the items before they are finally used in research.

The various types of tests that could be used for data collection in research include: intelligence tests, aptitude tests, achievement tests, sociometric tests which measure interpersonal relationship skills in a group.

Self Assessment Exercise 14.2:

1. Differentiate between interest inventory and sociometric techniques.
2. Explain the two broad types of tests.

4.0 CONCLUSION

In this unit, you have gone through some other methods and instruments for data collection in research. Whichever method you choose to use, you need to trial-test the measuring instrument using a few subjects whose characteristics are similar to those in the sample. The multi-faceted purpose of trial-testing is to ensure a satisfactory level of functionality, to estimate reliability, to obtain new insights, and to eliminate ambiguities. You have to avoid instrumental problems which may be mistaken for genuine difficulties in the research. This may lead to unnecessary expensive repetitions or abandoning of the research erroneously. Trial-testing of the instrument makes you see the feasibility or otherwise of the research study.

5.0 SUMMARY

In this unit, you were able to study five other methods of data collection. Rating scales are developed to discriminate human behaviour into categories or levels. Attitude scales are developed to measure feelings, emotions and personality of the individuals. The Likert scale, Thurnstone scale and Guttmann scale belong to this category. Interest inventories are used for measuring person's likes and dislikes.

Sociometric technique is used for measuring mental/cognigive, psychomotor, emotional etc. abilities/tracts. It could be classified into norm-referenced and criterion-referenced tests.

6.0   TUTOR MARKED ASSIGNMENT

1.   Construct a 10-item behaviour rating scale for the measurement of your students' behaviour in your practical classes.

2.   Construct a 10-item attitude questionnaire for the measurement of your students' attitude towards your practical classes.

Answer to SAE Question 14.1

Students/learners are expected to construct a 5-item instrument for the measurement in an identified research problem.

Answer to SAE Question 14.2

Interest inventory is an instrument used for measuring individuals' interest in an activity, event, programme, etc. while sociometric technique is used for measuring the social structure of a group.

The two broad types of tests are: norm-referenced tests and criterion-referenced tests.

Norm-referenced which are tests given to individuals to compare their scores to those of other individuals or groups called a norm group.

Criterion-referenced which are designed to measure some specified behaviour on a criterion that has been established by the teacher.

7.0   REFERENCES AND FURTHER READINGS

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UNIT 15 VALIDITY AND RELIABILITY OF AN INSTRUMENT

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1.0 INTRODUCTION

In this module, we have been talking about instruments for data collection in research. An instrument is a measuring device. It could be a questionnaire, observation protocol or test measuring intelligence or achievement. You have to note that if a study is very well designed but uses faulty instruments, the findings would be completely invalidated.

It is therefore very important that when you design a very good study, you will match it with appropriately and carefully developed and validated instruments. The instrument has to be valid and reliable to serve the purpose of the study.

In this unit, you will be studying the validity and the reliability of the instruments which you construct for your data collection in research.

2.0 OBJECTIVES

At the end of this unit, you should be able to:

(i)   explain measurement error;
(ii)   define validity of an instrument;
(iii)   discuss the types of validity;
(iv)   explain the various ways of estimating reliability.

3.0 MAIN CONTENT

3.1   Measurement Error

Errors in measurement could arise from faulty instruments incorrect interpretations of the values obtained or instability in the behaviour of the respondents or testees. These errors could be systematic or random.

A systematic error can occur when the errors are very frequent and are made in one direction away from the true score. Take for instance, your table clock in your office which is always adding time or always faster than the true time or an achievement test which keeps reporting very high scores for every testees.

Random errors can occur when measurement values deviate from the true score and as frequently in one direction as another. If you take the clock as an example, you will see that sometimes the clock will gain time and lose time on the other times. Random error can be attributed to chance factors. It should as much as possible be estimated and adjusted for or its sources eliminated.

In the case of the clock in your office, how do you think you can eliminate the error? Your answering have been to improve the working condition or to replace it. An instrument should as much as possible be designed to measure the true score. The degree to which an instrument measures the true score is an indication of two very important factors. These are reliability and validity. We are going to look at these in the next two sections. Meanwhile, note that the degree of random error is inversely related to the degree of reliability while the degree of non-random error is inversely related to the same variable or when you use a large sample in your study, random errors tend to average out over repeated measurements.

Therefore, to improve reliability of an instrument, the best strategy is to use multiple measures, multiple measurements and multiple investigators. This is what the triangulation theory of Denzin (1978) specified.

3.2   Validity

You have been reading about validity and reliability. What is validity? It refers to the extent to which an instrument measures exactly what it purports to measure and nothing else. As a researcher, you are faced with several educational variables for measurement. These include: intelligence, attitude, achievement, aptitude, creativity among others.

Validity is always specific to some particular use. An instrument may be valid for one purpose, but not for another. You should therefore ask yourself whether the instrument is valid for the purpose to which you intend to put it. For instance, an instrument that has a high validity in reasoning ability may have very low validity for measuring arithmetic ability. An instrument may be valid for one culture or geographical setting, but not valid for another.

Validity can be classified into three major types. These are content, construct and criterion-related validities.

3.2.1   Content Validity

This refers to the degree with which the items of an instrument are representative of the content and behaviours specified by the theoretical concept being measured. It is estimated using the sample of items and comparing them with the content and behaviours which they should represent. A high degree of content validity is achieved if the sample of items covers all aspects of the content and behaviours.

A way of estimating the content validity of a test is by constructing a test-blue point otherwise called table of specification. This systematically specifies the content, objectives and evaluation techniques in the process of generating valid test instruments.

Face-to-face validity – This is a type of content validity. Most people, some of the times, erroneously equate it with content validity. But it refers to the subjective judgement of assessors about what an instrument appears to be measuring, that is, on the face value. There is no systematic procedure adopted for this purpose.

3.2.2   Construct Validity

This refers to the extent to which a particular instrument reflects hypothetical constructs presumed to underlie the performance and also the extent to which the instrument reflects the theories underlying the constructs. Some psychological concepts such as: intelligence, creativity, anxiety, attitude, reasoning etc. which cannot be seen with the eyes but their existence can only be inferred from manifested characteristics or behaviour are called constructs. For you to design a test, you have to ask: To what extent do certain explanatory concepts or qualities account for students' performance on a test?

The process of construct validity is easy to determine only when the construct is specified. Therefore, the construct should be precisely defined before you undertake to develop the instrument. Let us take students' interest in your subject, for instance. In the definition of interest, you specify such behaviour as prompt attendance, alertness, carrying out assignments, smiles on their faces when they understand, curiousity to learn, asking relevant questions etc. So when you administer a testing the subject and notice that students who exhibit the above-mentioned behaviours perform better, you can say that the test has a good construct validity.

3.2.3   Criterion Related Validity

This refers to the extent to which an instrument yields the same results as a more widely accepted measure. If you want to verify the degree of criterion-related validity of your test, you can compare the result of your test and that from a known test like the Standford – Binet Intelligence Test, using correlation coefficients. If your test correlates highly with the known test, you say it possesses a high degree of criterion-related validity. This is possible if the two tests are on a related area. For instance, Eyesenk Personality Inventory can be used as a criterion for a new personality measures. Criterion-related validity is of two types. They are concurrent and predictive validities.

(a)   **Concurrent Validity**:

This is applicable when a new instrument is administered at the same point in time as well as a known instrument. It can be very useful if the equivalent form of an instrument is required concurrent validity is attained when the correlation between the results of the newly developed instrument and those of a suitable equipment is sufficiently high.

(b)   **Predictive Validity**:

This is concerned with the prediction of future performance. It is the degree to which predictions made by an instrument are confirmed by the later behaviour of respondents. For instance, you can use the results from an intelligence test or an aptitude tests to predict success at school. You can also use the results from JAMB or UME to predict the performance of students in undergraduate courses. A second instrument can be administered after the behaviour which the first instrument attempts to predict has occurred. The results yielded by the two instruments are correlated. A sufficiently high correlation index shows predictive validity.

Self Assessment Exercise 15.1:

(i)   What is validity?
(ii)   Describe the two types of criterion-related validity.
(iii)   What are the two types of measurement errors?

3.3   Reliability

This is a common word in everyday usage. But in educational research, it refers to the extent of consistency with which an instrument measures what it is measuring. An instrument is regarded as reliable if it yields the same results time after time, or if similar results come out consistently under the same or slightly different test conditions. It is very important that the test you are going to use for your research project is reliable, especially if your research study is going to involve pretest and posttest, experimental and control groups. If your instrument has low level of reliability, it may not be able to discriminate between pretest scores and posttest scores. It may not discriminate effectively between the performance of the experimental and control group. Correlation coefficient is an important statistical procedure for determining the degree of reliability. You will be learning more of it in the module containing statistics. The methods of estimating reliability include: test-retest, alternative form, split-halves and internal consistency methods.

3.3.1   Test – Retest Method

This involves the repeated administrations of the instrument to the same people on two occasions. It is usually recommended that the time interval be between two weeks and one month. The scores resulting from the two administrations of the test are correlated to determine the coefficient of stability. You will have to note that if the time interval is too short, the memory of the responses to the first test will affect the second. A long time interval may create opportunity for candidates to learn more or to forget what they had known.

3.3.2 Alternate-Form Method or Equivalent Form Method

In this method, two parallel forms of an instrument are administered to the same respondents at a single sitting or with a short time interval between the two. The scores from the two tests are correlated to determine the coefficient of equivalence.

You have to note that parallel forms of an instrument are expected to have the same specification of content and objectives and measures the same behaviours.

3.3.3 Split-Halves Method

This is a measure of internal consistency. It requires the administration of a single test instrument to the students once then the items of the instrument are split into two parts.

In other words, the total set of items is divided into halves. The scores on the halves are correlated to obtain the estimate of reliability. You can split the items using odd and even numbers, or randomly dividing the items into two groups etc. You can see that the result you get from it for a half test. Therefore, it is corrected using the Spearman-Brown formula:

$$r = \frac{2r_{\frac{1}{2}}}{1 + r^{\frac{1}{2}}} \quad \text{or} \quad r_c = \frac{nr_s}{1+(n-1)r_s}$$

where r = reliability of the whole test
$r^{\frac{1}{2}}$ or r_s = reliability of the half test.

3.3.4 Internal Consistency Method

The estimate here is obtained through an analysis of the individual items following a single administration of the measuring instrument.

(a) **The Rational Equivalence Method**:

This uses the formation of equivalent halves by considering all possible splits and computing the reliability coefficient by employing either Kuder Richardson formula (for dichotomous items) or Cronbach's alpha(for Likert scales). Kuder and Richardson (1937) developed coefficients for estimating the reliability of instruments composed of dichotomously-scored items. You may note that dichotomous items are scored one or zero for presence or absence and for positive or negative responses to characteristics under investigation.

The most widely used formulae are numbers 20 and 21 otherwise called KR20 and KR21. KR21 is simpler and can be used for instruments developed by individual researchers, while KR20 which is more technical is used for determining the degree of reliability of standardized tests.
KR20 is given by; $KR20 = (\underline{\text{ N }}) \; (1 - \sum P_i q_i)$

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$$\frac{}{N-1} \quad Qt^2$$

where N = the number of dichotomous items
       Pi = the proportion of positive responses to the ith item
       q_i = $1 - P_i$
       $\sum$ = summation
       Q^2t = the variance of the total composite

KR21 is given by; $KR21 = \left(\dfrac{N}{N-1}\right) \dfrac{(Q_t - \sum Pq)}{Qt^2}$

where N = the total number of items
       P = the proportion of positive responses to the each item
       q = the proportion of negative responses to each item
       $\sum$ = summation
       Q^2t = variance of the total composite

Cronbach's alpha is a unique estimate of the expected correlation of one instrument with an alternative form that can be used for polychotomous items while Cronbach alpha is a generalization of it.

Cronbach's alpha is given by $\infty = \left(\dfrac{N}{N-1}\right) \dfrac{(1 - \sum Q^2(Pq_i))}{Qt^2}$

where N   = the number of items
       $\sum Q^2(Y_i)$ = the sum of item variances
       Qt^2 = the variance of the total composite

(b)   **Standard Error of Measurement**:

This is an estimate of test reliability obtained from the reliability coefficient and the standard deviation of test scores. It is inversely related to the reliability coefficient.

(c)   **Factor Analysis**:

This is used to obtain estimates of reliability which approximate the true reliability better than all other coefficients. It is represented by coefficient theta ($\emptyset$) which is derived from principal components factor analysis. It can be used to estimate reliability.

Another coefficient called omega (Ω) also derived from factor analysis can also be used to estimate reliability.

Do not be scared by these estimates of reliability. You may not need to use them at this stage. They are mentioned for you to know that there are more methods.

Self Assessment Exercise 15.2:

(i)   What is reliability of an instrument?
(ii)   What are the methods of estimating reliability?

4.0   CONCLUSION

In this unit, you learnt the methods of validity of your instruments and also the ways to estimate the reliability. From this, you have seen that it is very important to make your instruments valid and reliable. This is because any instrument which is properly constructed to have adequate validity and reliability, and also properly administered will yield quality data that will make your research report to stand a good change of being well presented.

5.0   SUMMARY

In this unit, you learnt that measurement error could be systematic or random. Validity is the extent to which an instrument measures what it purports to measure and nothing else. There are three major types of validity. These are content including face validity, constructs validity and criterion-related validity which includes concurrent and predictive validities.

Reliability is the extent of consistency with which an instrument measures what it is measuring. The methods of estimating reliability include test-retest, alternative form, split-halves and internal consistency methods.

6.0   TUTOR MARKED ASSIGNMENT

(i)   What are the two types of measurement error?
(ii)   What is validity?
(iii)   Describe any two types of validity.
(iv)   What are the methods of estimating reliability?

Answer to SAE Question 15.1

Validity refers to the extent to which an instrument measures exactly what it purports to measure and nothing else. As a researcher, you are faced with several educational variables for measurement. These include: intelligence, attitude, achievement, aptitude, creativity among others.

(a)   Concurrent Validity:

This is applicable when a new instrument is administered at the same point in time as well as a known instrument.

It can be very useful if the equivalent form of an instrument is required concurrent validity is attained when the correlation between the results of the newly developed instrument and those of a suitable equipment is sufficiently high.

(b)   Predictive Validity:

This is concerned with the prediction of future performance. It is the degree to which predictions made by an instrument are confirmed by the later behaviour of respondents. For instance, you can use the results from an intelligence test or an aptitude tests to predict success at school. You can also use the results from JAMB or UME to predict the performance of students in undergraduate courses.

A second instrument can be administered after the behaviour which the first instrument attempts to predict has occurred. The results yielded by the two instruments are correlated. A sufficiently high correlation index shows predictive validity.

Errors in measurement could arise from faulty instruments incorrect interpretations of the values obtained or instability in the behaviour of the respondents or testees. These errors could be systematic or random.

A systematic error can occur when the errors are very frequent and are made in one direction away from the true score. Take for instance, your table clock in your office which is always adding time or always faster than the true time or an achievement test which keeps reporting very high scores for every testees.

Random errors can occur when measurement values deviate from the true score and as frequently in one direction as another. If you take the clock as an example, you will see that sometimes the clock will gain time and lose time on the other times. Random error can be attributed to chance factors. It should as much as possible be estimated and adjusted for or its sources eliminated.

Answer to SAE Question 15.2

An instrument is regarded as reliable if it yields the same results time after time, or if similar results come out consistently under the same or slightly different test conditions. It is very important that the test you are going to use for your research project is reliable, especially if your research study is going to involve pretest and posttest, experimental and control groups.

The methods of estimating reliability include: test-retest, alternative form, split-halves and internal consistency methods.

(a) Test – Retest Method

This involves the repeated administrations of the instrument to the same people on two occasions. It is usually recommended that the time interval be between two weeks and one month.

The scores resulting from the two administrations of the test are correlated to determine the coefficient of stability. You will have to note that if the time interval is too short, the memory of the responses to the first test will affect the second. A long time interval may create opportunity for candidates to learn more or to forget what they had known.

(b) Alternate-Form Method or Equivalent Form Method

In this method, two parallel forms of an instrument are administered to the same respondents at a single sitting or with a short time interval between the two. The scores from the two tests are correlated to determine the coefficient of equivalence.

You have to note that parallel forms of an instrument are expected to have the same specification of content and objectives and measures the same behaviours.

(c) Split-Halves Method

This is a measure of internal consistency. It requires the administration of a single test instrument to the students once the items of the instrument are split into two parts.

In other words, the total set of items is divided into halves. The scores on the halves are correlated to obtain the estimate of reliability. You can split the items using odd and even numbers, or randomly dividing the items into two groups etc. You can see that the result you get from it for a half test.

(d) Internal Consistency Method

The estimate here is obtained through an analysis of the individual items following a single administration of the measuring instrument.

7.0 REFERENCES AND FURTHER READINGS

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MODULE 4

UNIT 16   INTRODUCTION TO STATISTICS

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1.0   INTRODUCTION

In the previous modules/units, you worked through the different methods of collecting data in research. The question is: what do you do with this seemingly unmanageable bulk of data?

This question will take us to 'Data Analysis', which we shall describe "as the process of organizing and summarizing data in order to provide answers to the research questions or test hypotheses stated in the study". This process, most of the times, involves the use of statistical procedures to summarise and describe the characteristics of samples and populations of the study.

In this unit, we shall first look at the meaning of statistics, the types of statistics and organisation of data.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   define the concept statistics;
(ii)   explain the types of statistics;
(iii)   organize a set of scores under (a) sequencing, (b) frequency distribution table, (c) bar chart.

3.0   MAIN CONTENT

3.1   Meaning of Statistics

Statistics, as a word, has different shades of meaning. These meanings can be in the plural form or singular form.

(i)   **It is regarded as a state arithmetic**: In this case, it involves observing, recording and computing the amount of resources, financial, human and material, available to a government for the purpose of governance or war. Every government needs accurate statistics to make governance easier.

(ii)   **Statistics can be regarded as pieces of information**: Statistics imply data or pieces of information e.g. the age of Bayo, the height of Ike, the weight of Audu, the number of students in Mr. Bassey's class, the number of classes in JSS. 1, Federal Government College, Okigwe. Others are: number of accidents on road A for a year, number of candidates employed by company B in 1999, the number of workers retrenched during the reform programme.

(iii)   **Statistics as summaries of information**: In this case, it can be used as summaries of information about a small group of individuals selected from large group for the purpose of investigating the large group. This is called sample statistics. This can be in the form of sample size, mean, median, variance, standard deviation, mode, etc. Each of these is regarded as a statistic.

(iv)   **Statistics as Mathematical function or models**: In this case, it is used for comparison of two or more samples. In other words, it can be used for pair wise differences, ratios of 2-test, 2-score, t-score, t-test, f-test etc are examples.

(v)   **Statistics as academic discipline**: In this case, it is regarded as a subject or field of study, in which case, it is an aspect of applied mathematics.

According to Spiegel (1972), statistics is concerned with scientific methods for collecting, organizing, summarizing, presenting and analysing data as well as drawing valid conclusions and making reasonable decisions on the basis of such analysis.

You can get so many definitions of statistics from so many textbooks. Since this course is not purely on statistics, we shall look at statistics as the science of decision making in the face of uncertainties. Look at Hays (1973). He says that statistics serves in two capacities:

(1)   It gives methods for organizing, summarizing and communicating data, and
(2)   It provides methods for making inference beyond the observations.

In summary, statistics involves observation, collection of data, organisation of data, presentation of data, analysis of data, interpretation of data and decision making. You may wish to note that statistics, when used as a subject, is not the plural of statistic. A statistic is a measure which we obtain by observing the characteristics of the sample. You have learnt that we study a sample in order to make inferences about the population.

Therefore, the characteristic of the population which we estimate from a sample characteristic or statistic is called a parameter. The mean of a sample is 50. The mode of the distribution is 45. It means that 50 is a statistic, 45 is also a statistic. You can give other examples.

3.2   Types of Statistics

You may have heard about different types of statistics, such as Correlational, probability, parametric, non-parametric, etc. statistics. All these have been grouped into two major types. These are descriptive and inferential statistics. In this section, you will read a brief presentation of these major types.

3.2.1   Descriptive Statistics

This can be described as a type of statistical application which is concerned with the organisation and presentation of data in a convenient, usable and communicable form. Spiegel (1972) described it "as the set of methods serving the functions of organizing, summarizing and communicating data.

You can use descriptive statistical methods when you are interested in merely describing the characteristics of the group or the sample of study. It means that the descriptive analysis which you make will not generalize beyond the particular group or sample observed. In the same way, conclusions drawn from the study are limited and apply only to that group of study.

3.2.2   Inferential Statistics

These are statistical methods used for arriving at conclusions extending beyond immediate data. They are the phases of statistics which can be used to deal with conditions under which conclusions are drawn about a larger group based on data collected from some smaller group or groups chosen from and related to the larger group.

Inferential statistics can be described as a statistical procedure which makes use of sample statistics to make inferences about the population parameters. It involves the process of sampling that is representative of the population. It makes use of the aspect of inferential

statistics called parametric statistics which are powerful tests that make use of the normal probability model, or making comparison involving the setting up of confidence limit, setting up of the degree of freedom etc. We shall discuss this later.

3.3   Benefits of the Study of Statistics

When you study statistics, you stand to derive some general benefits. These benefits focus on the useful knowledge, skills, capabilities or dispositions which you will acquire from the study of, or training in statistics. They vary, according to the extent and level of study, or training in the subject. Some of these benefits include that the study of statistics will enable you to:

1. Acquire knowledge and skills in observation, collection, organisation, communication, analysis of data, drawing inferences from the analysis of data and making sound decisions;

2. Make meaningful contributions to local, national or international debates on topical issues;

3. Read, understand and interpret communicated data, follow inferences drawn therefrom and appreciate decisions made consequent upon the inferences drawn;

4. Successfully execute empirical research. No reasonable or worthwhile empirical research can be carried out or reported without statistics for answering research questions, testing hypotheses or taking decisions and making predictions;

5. Read, interpret and make use of research reports or articles;

6. Follow and critique contributions to debates presented with facts and figures;

7. Acquire the skills and techniques for estimating, predicting and projecting into the future based on the previous and present data;

8. Draw sound conclusions based on some pieces of information that are probable or not quite certain.

Self Assessment Exercise 16.1:

i.   What is statistics?
ii.   What are the two types of statistics?

3.4   Organisation of Data

Data collected in education can be from various sources and can be in various forms, such as: opinions, scores/marks, frequencies, verbal etc.

The data can be organized or arranged to make them meaningful. In this section, we shall look at sequencing, tables, frequency distribution tables, bar charts, etc.

3.4.1 Sequencing

This involves arranging the data in order of magnitude – ascending or descending order. See example below:

Example 1:

Given that the test scores of 10 students in statistics are:

8, 9, 2, 5, 7, 6, 4, 9, 8, 3.

This could be arranged in ascending order thus:

2, 3, 4, 5, 6, 7, 8, 8, 9, 9 or in descending order thus: 9, 9, 8, 8, 7, 6, 5, 4, 3, 2.

If the data consists of names, they can be arranged in alphabetical order. If they consists of objects, events, animals, etc. they can be arranged according to kinds, species, groups etc.

3.4.2 Tables

A table can be regarded as a two-dimensional representative of statistical information or data. Tables can be simple or complex as shown in the examples on the enrolment of pupils in central school Umuihi from 2000 to 2007, and Distribution of Mathematics teachers in Okigwe Zone in the year 2006.
Example 1.
Table 16.1:   Pupils' Enrolment in Central School, Umuihi, 2000 – 2007.

S/N	Year	Boys	Girls	Total
1.	2000	200	170	370
2.	2001	210	165	375
3.	2002	230	170	400
4.	2003	220	175	395
5.	2004	240	180	420
6.	2005	225	170	395
7.	2006	242	182	424
8.	2007	250	200	450

Example 2.

Table 16.2:   Distribution of Mathematics Teachers in Okigwe Education Zone

S/N	Local Government	No. of Teachers
1.	Ehime Mbano	525
2.	Ihitte / Uboma	425
3.	Isiala Mbano	600
4.	Obowo – Etiti	400
5.	Onuimo	325
6.	Okigwe	425
	Total	**2,700**

3.4.3   Frequency Distribution Table

A frequency distribution table shows the number of times each score, value or item occurs in a distribution.   It consists of two columns – one for the scores/items and the other for the frequency.

Example 3:

The scores of some students in a Mathematics test are given below.   Present the scores in a frequency table.

10, 15, 18, 12, 14, 15, 20, 15, 16, 11, 12, 14, 19, 20, 17, 18, 15, 13, 11, 12, 19, 13, 10, 14, 17, 19, 16, 15, 15, 15.

Table 16.3:   Frequency Distribution Table

S/N	Score	Tally	Frequency
1.	10	\\	2
2.	11	\\	2
3.	12	\\\	3
4.	13	\\	2
5.	14	\\\	3
6.	15	⊬⊬⊬ \\	7
7.	16	\\	2
8.	17	\\	2
9.	18	\\	2
10.	19	\\\	3
11.	20	\\	2
			30

Note that when you tally, each number tallied is neatly cancelled to avoid confusion.

3.4.4   Grouped Frequency Distribution

Some of the times, the number of scores may be so large that it becomes necessary to group several scores together. A group of score values form a class interval.

Example 4:

Present the scores below in a grouped frequency table.

55, 62 60, 50, 52, 58, 55, 60, 51, 55, 68, 55, 47, 39, 58, 42, 47, 42, 48, 55, 48, 46, 55, 51, 58, 65, 52, 35, 54, 55, 52, 56, 46, 65, 53, 34, 48, 50, 39, 59, 53, 52, 33, 48, 65, 60, 36, 68, 45, 62, 59, 60, 33, 40, 61, 38.

In order to determine the interval or class size:

(i)   Find the range. This is given by the highest score minus the lowest score. From the scores, we have 60 – 33 = 27.

(ii)   Determine the number of groups. It has to be between 10 and 20.

(iii)   Divide the range by the number e.g. 27 ÷ 12 = 3 (approximate).

(iv)   Draw a table and tally the scores according to groups.

Table 16.4:   Grouped Frequency Distribution Table

S/N	Class Interval	Tally	Frequency		
1.	66 – 68	\\	2		
2.	63 – 65	\\\	3		
3.	60 – 62	₩₩ \\	7		
4.	57 – 59	₩₩	5		55, 62 60, 50, 52, 58, 55, 60, 51,
5.	54 – 56	₩₩ \\\\	9		55, 68, 55, 47, 39, 58, 42, 47, 42,
6.	51 – 53	₩₩ \\\	8		48, 55, 48, 46, 55, 51, 58, 65, 52,
7.	48 – 50	₩₩ \	6		35, 54, 55, 52, 56, 46, 65, 53, 34,
8.	45 – 47	₩₩	5		48, 50, 39, 59, 53, 52, 33, 48, 65,
9.	42 – 44	\\	2		60, 36, 68, 45, 62, 59, 60, 33, 40,
10.	39 – 41	\\\	3		61, 38.
11.	36 – 38	\\	2		
12.	33 – 35	\\\\	4		
			56		

Self Assessment Exercise 16.2:

Present the scores below in a grouped frequency table.
16, 19, 24, 13, 17, 29, 20, 18, 21, 23, 19, 22, 23, 21, 19, 18, 22, 26, 28, 15, 27, 20, 25, 14, 28, 29, 14, 13, 22, 21, 23, 19, 21, 24, 17, 25, 26, 16, 27, 15, 21, 20, 23, 18, 21, 20, 24, 26, 21, 22.

3.5 Graphical Representations

In the last section you learnt and practiced how to organize data using frequency distribution tables. Sometimes data are organized in form of graphs. This is known as graphical

representations. There are different types—bar chart, histogram, frequency polygon, pie chart and ogive. In this section we shall discuss these graphs or charts.

3.5.1 Bar Graph (Chart)

The bar chart consists of rectangular representations of clusters of a given set of data. The bars have equal width, but the heights vary in proportion to the frequencies of the clusters being represented. Bar charts are also drawn from frequency distribution tables for grouped data. To draw a bar chart the class interval is plotted on the X-axis against the frequency on the Y-axis. Let us use the example in table 16.4 to illustrate this.

Example 5:

The distribution of qualified teachers, according to some subjects in a college is given below. Use it to draw a bar graph. English – 15, Mathematics – 20, Chemistry – 8, Physics – 7, Biology – 12, Geography – 5, Technical Drawing – 3, Economics – 14, Igbo – 1.

Choose a suitable scale on the vertical axis to represent the frequencies. For instance, let 5mm represent 2 units. On the horizontal axis, let 15mm represent one unit.

Note:

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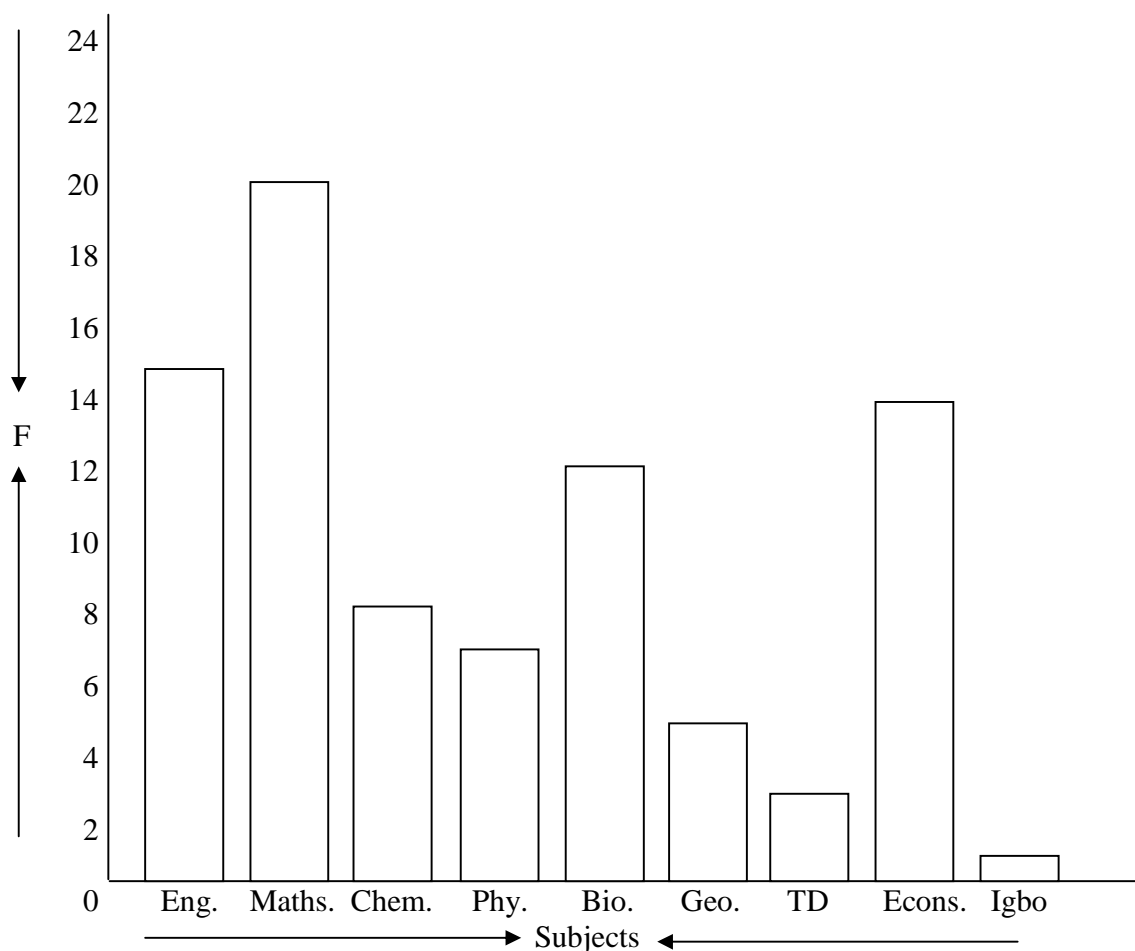
(i) The frequencies are scaled on the vertical axis,
(ii) Bars do not touch each other or the 00 point

Self Assessment Exercise 16.3:

Some of the items in a school workshop are given below. Use it to construct a bar chart.

1. Hammer – 30
2. Plier – 25
3. Files – 25
4. Punches – 20
5. Spanners – 15
6. Dies – 10
7. Tapes – 5
8. Screw drivers – 45
9. Saws – 25
10. Vices – 20

4   CONCLUSION

In today's world, decisions are taken based on activities which are becoming more and more empirical, quantitative and precise decisions and inferences are drawn from real life experiences, which are codified or quantified. Decisions are based on statistical data and perceptions are expressed in codes or figures.

It has become very necessary therefore that people in all walks of life should get used to statistics. This can be done in varying degrees. People go to collect data everyday fro different purposes and needs. These data must be organized and presented in the form of records for these who need them. Since not much meaning can be made out of a totally disorganized situation. It becomes imperative that the data collected must be organized in appropriate form. This unit has exposed all these to you.

5   SUMMARY

In this unit, you have learnt that the word statistics has different shades of meaning. It is regarded as a state arithmetic, a piece or pieces of information, summaries of information, mathematical model and an academic discipline. As an academic discipline or a subject of study, it involves observation, collection of data, organisation of data, presentation and representation of data, analysis of data, interpretation of data and decision making. We also discussed the types of statistics. In this case, you were told that there are two major types, viz: descriptive and inferential statistics. The benefits of the study of statistics were also discussed. You also learnt that data collected from various sources need to be organized or arranged to make them meaningful.

In this unit, we looked at sequencing, which involves arranging the scores in order either of ascending or descending. We also looked at tables as two-dimensional representations of statistical data. They can be simple or complex. You also learnt about another type of table which shows the number of times or score values or items occur in a distribution. This is called

frequency distribution table. This table can be for both ungrouped and grouped frequency distributions.

Finally, you learnt how to draw the bar chart which is made up of rectangular representations of clusters of a given set of data. In the next unit, you will learn about other methods of presenting and representing statistical data.

6   TUTOR MARKED ASSIGNMENT

1. What is statistics? What are the two types of statistics?

2. Given that the achievement test scores of some students in Measurement and Evaluation are given below:

   80, 61, 57, 52, 48, 46, 35, 59, 78, 66, 59, 51, 37, 57, 70, 63, 57, 50, 47, 59, 28, 25, 73, 64, 58, 47, 40, 25, 65, 55, 72, 48, 41, 28, 69, 55, 50, 45, 40, 24, 60, 63, 35, 71, 40, 45, 33, 31, 38, 36.

   Using a class interval of 5, construct a frequency distribution table for the data.
3. Use the following data to construct a bar chart of some roads and the number of vehicles plying on them per hour .

   1. Jos – Bauchi = 150
   2. Lagos – Ibadan = 500
   3. Aba – Owerri = 450
   4. Abuja – Lokoja = 350
   5. Enugu – Port Harcourt = 400
   6. Benin – Auchi = 200
   7. Calabar – Aba = 300
   8. Kaduna – Kafanchan = 250
   9. Owerri = Onitsha = 550

Answer to SAE Question 16.1

Statistics is the science of observation, collection of data, organisation of data, presentation of data, analysis of data, interpretation of data and decision making.

The two types of statistics are: descriptive statistics and inferential statistics.

Answer to SAE Question 16.2

Range =   29 – 13 = 16

Class interval = 16/6 = 3

S/N	Class Interval	Tally	Frequency
1.	28 – 30	ⱯⱯⱯ	4
2.	25 – 27	ⱯⱯⱯ \\	7
3.	22 – 24	ⱯⱯⱯ ⱯⱯⱯ \	11
4.	19 – 21	ⱯⱯⱯ ⱯⱯⱯ ⱯⱯⱯ	15
5.	16 – 18	ⱯⱯⱯ \\	7
6.	13 – 15	ⱯⱯⱯ \	6
			50

Answer to SAE Question 16.3
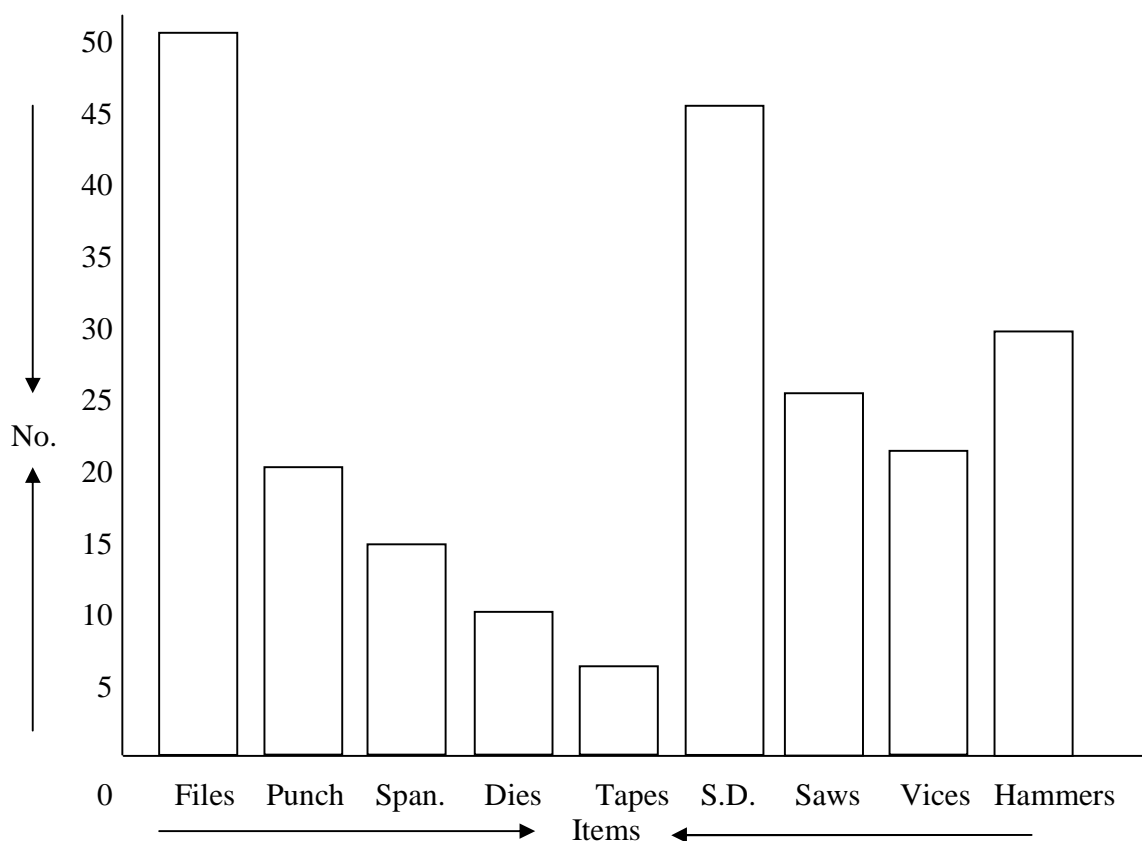
7   REFERENCES AND FURTHER READINGS

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UNIT 17   OTHER METHODS OF REPRESENTING DATA AND MEASURES OF CENTRAL TENDENCY

Table of Contents

1.0   INTRODUCTION

In the last unit, you were exposed to the concept of statistics and organisation of data. You also read through the bar chart which is a graphical way of representing data. In this unit, you will continue to be exposed to other ways of representing data. These include pie chart, histogram, frequency polygon and ogive. We will also look at the measures of central tendency. As this is not a complete course on statistics, we may not be so detailed in the presentations.

2.0   OBJECTIVES

By the end of this unit, you should be able to:

(i)   construct a pie chart using given data;
(ii)   construct and describe histogram;
(iii)   draw a composite table and construct a frequency polygon;
(iv)   draw a composite table and construct an ogive;
(v)   calculate the mean, median and mode of a given data.

3.0   MAIN CONTENT

3.1   Pie Chart

This is used to represent both discrete and continuous data. It involves using a circle to represent a set or groups of items or scores. Each group or item is represented by a sector of the circle.

The angle subtended at the centre by the sector is proportional to the frequency of the items or scores represented. It implies that the total frequencies of the set are represented by 360^0.

Example 17.1:

Construct a pie chart to represent the data below:

The distribution by local government area of Basic Technology teachers in Okigwe Zone is as follows:

EHIM = 60, IHITTE/UBOM = 50, ISIALA = 65, ONUIMO = 40, OBOWO = 35, OKIGWE = 30.

To construct the pie chart:

i.   Find the angle that is subtended at the centre by each group:

    (a) EHIME = $\dfrac{60}{280}$ x $\dfrac{360}{1}$ = 77.14^0

    (b) IHITTE/UBOMA = $\dfrac{50}{280}$ x $\dfrac{360}{1}$ = 64.29^0

    (c) ISIALA= $\dfrac{65}{280}$ x $\dfrac{360}{1}$ = 83.57^0

    (d) ONUIMO = $\dfrac{40}{280}$ x $\dfrac{360}{1}$ = 51.43^0

    (e) OBOWO = $\dfrac{35}{280}$ x $\dfrac{360}{1}$ = 45.00^0

    (f) OKIGWE = $\dfrac{30}{280}$ x $\dfrac{360}{1}$ = 38.57^0

ii.   With the aid of a pair of compasses, any convenient radius, draw a circle.

iii.   Using your protractor, mark out the angles corresponding to each group or category of items, to the nearest degree.

iv.   Label the sectors of the circle corresponding to the items.

Distribution by LGA of Basic Technology Teachers in Okigwe Zone
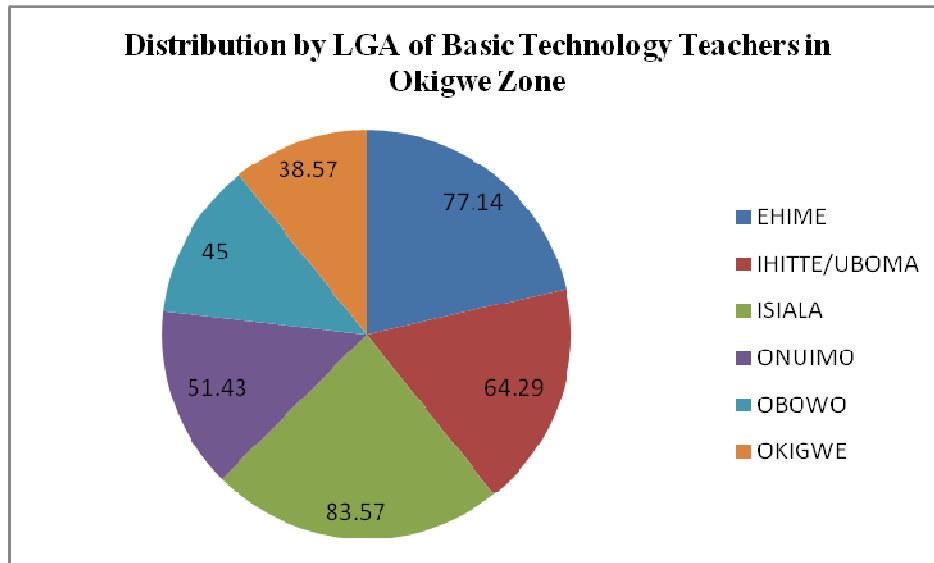
3.2 Histogram

In the last unit, you studied the bar chart, which is used mainly for the representation of discrete data. In the construction, you noticed that the rectangles do not touch each other. The histogram is used to represent data on a frequency distribution table like the bar chart. It is made up of rectangular bars of equal joined to one another, and it is used for continuous data. At the vertical axis, we have the frequencies and at the horizontal, we have the corresponding class intervals. The difference between the two is that, for bar chart the class intervals are used while for histogram the exact class boundaries are used. There are two exact class boundaries—upper and lower exact class boundaries. These are obtained by subtracting 0.5 from the upper boundary and adding 0.5 to the lower boundary. Alternatively, For the exact lower limit of the first group (20 – 24), we have

$$\frac{19 + 20}{2} = 19.5$$

And for the exact upper limit $= \frac{24 + 25}{2} = 24.5$

Example 16.2:

Using the data below, construct a histogram:

Class Interval	20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 – 64	65 – 69	70 – 74	75 – 79
Frequency	3	5	8	10	13	15	12	8	6	5	3	2

To construct a histogram:

1. Compose a composite table having the class interval, the exact class limits, and the frequencies.

2. Choose suitable scales and draw the vertical and horizontal axes.

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3. Mark of the frequencies on the vertical axis and the exact limits or real limits on the horizontal axis.

4. Draw the rectangular bars on each boundary with the height corresponding to the frequencies.

5. Draw arrows to show what is on the vertical and horizontal axes.

S/N	Class Interval	Real Exact Limit	Frequency
1.	75 – 79	74.5 – 79.5	2
2.	70 – 74	69.5 – 74.5	3
3.	65 – 69	64.5 – 69.5	5
4.	60 – 64	59.5 – 64.5	6
5.	55 – 59	54.5 – 59.5	8
6.	50 – 54	49.5 – 54.5	12
7.	45 – 49	44.5 – 49.5	15
8.	40 – 44	39.5 – 44.5	13
9.	35 – 39	34.5 – 39.5	10
10.	30 – 34	29.5 – 34.5	8
11.	25 – 29	24.5 – 29.5	5
12.	20 – 24	19.5 – 24.5	3
			90

19.5 24.5 29.5 34.5 39.5 44.5 49.5 54.5 59.5 64.5 69.5 74.5 79.5

→ Exact class boundaries   Histogram

Self Assessment Exercise 17.1:

An Education student of NOUN spent a total of ₦30,000.00 as follows:

Registration	=	N5,000.00
Course materials	=	N10,000.00
Examinations	=	N5,000.00
Transportation	=	N3,000.00
Stationeries	=	N2,000.00
Diskettes and CDs	=	N1,000.00
Note books	=	N2,500.00
Typing of assignments	=	N1,500.00

Represent these expenses in a pie chart.

3.3   Frequency Polygon

This is a line graph plotted using the frequencies against the mid-points of the class intervals.

Example 16.2:

Use the data below to construct frequency polygon.

Class Interval	33 –35	30 – 32	27 – 29	24 – 26	21 –23	18 – 20	15 – 17	12 –14	9 – 11
Frequency	3	5	8	10	13	15	12	8	6

To construct the polygon:

i.   Draw up a composite table having the class interval, the mid-points and the frequencies.
ii.   Choose suitable scales for the vertical and horizontal axes.
iii.   Plot the graph using the frequencies against the mid-points of the class interval.
iv.   To complete the polygon, add an interval at the top and below. Let the two intervals have zero frequencies.

S/N	Class Interval	Real Exact Limit	Frequency
1.	33 – 35	34	9
2.	30 – 32	31	2
3.	27 – 29	28	4
4.	24 – 26	25	8
5.	21 – 23	22	10
6.	18 – 20	19	7
7.	15 – 17	16	5
8.	12 – 14	13	3
9.	9 – 11	10	2

	6 – 8	7	0

Frequency Polygon
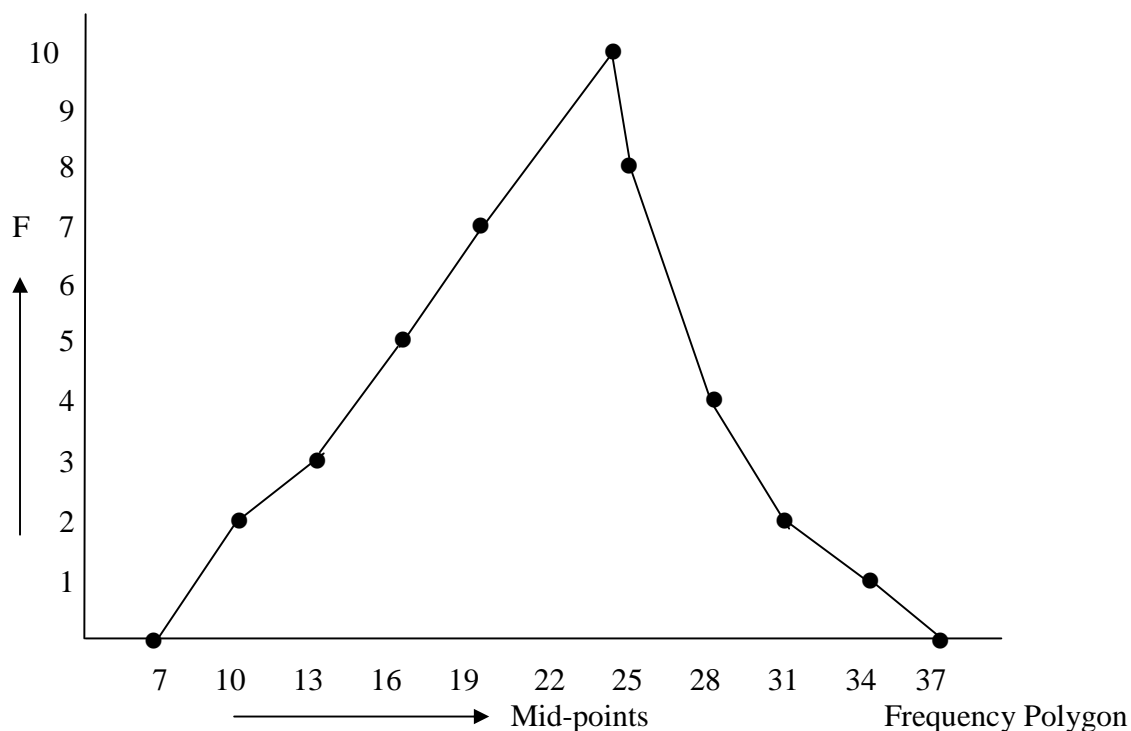
3.4   Ogive

This is a graph which involves the use of a smooth curve to join the Cartesian coordinate plots of cumulative frequencies against the real class boundaries. In other words, instead of the frequencies, it makes use of the cumulative frequencies. The graph gives shape like shallow 'S'.

Example 17.4:

Using the score groups below, draw an ogive or cumulative frequency curve:

Class Interval	5 –9	10 – 14	15 – 19	20 – 24	25 – 29	30 –34	35 – 39	40 – 44	45 –49	50– 54
Frequency	1	3	6	10	12	8	6	5	8	6

To draw the ogive:

i.   Compose a composite table having the class boundaries, the exact class limits, frequencies and cumulative frequencies.

ii. Choose a suitable scale to accommodate the highest cumulative frequency on the vertical axis and the class boundaries on the horizontal axis.

iii. Plot the points on the cumulative frequencies against the corresponding class boundaries.

iv. Join with a smooth curve.

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S/N	Class Interval	Real Exact Limit	Frequency	Cumulative frequency
1.	50 – 54	49.5 – 54.5	2	56
2.	45 – 49	44.5 – 49.5	3	54
3.	40 – 44	39.5 – 44.5	5	51
4.	35 – 39	34.5 – 39.5	6	46
5.	30 – 34	29.5 – 34.5	8	40
6.	25 – 29	24.5 – 29.5	12	32
7.	20 – 24	19.5 – 24.5	10	20
8.	15 – 19	14.5 – 19.5	6	10
9.	10 – 14	9.5 – 14.5	3	4
10.	5 – 9	4.5 – 9.5	1	1
			56	
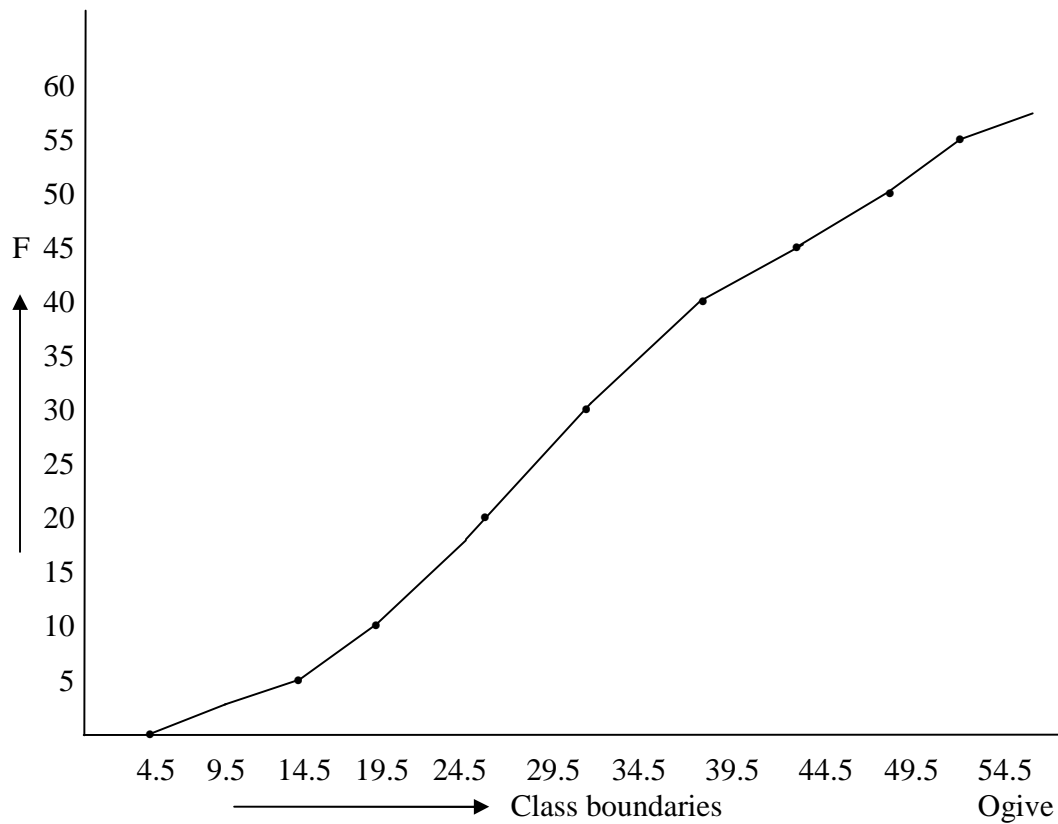
Ogive

Self Assessment Exercise 17.2:

Using the data below:

(i) Construct a frequency polygon, and
(ii) Construct an ogive.

Class Interval	10 – 12	13 – 15	16 – 18	19 – 21	22 –24	25 – 27	28 – 30	31 – 33	34 – 36	37 – 39	40 – 42	43 – 45
Frequencies	2	4	6	10	7	12	8	5	0	4	3	1

3.5 Measures of Central Tendency

In the last sections, you studied the graphical method of representing data. The measures of central tendency provide convenient way of summarizing data. This method involves finding a single measure which is typical of a set of scores. This measure of value can be used to 'capture' or represent a whole set of scores in such a way that it becomes the representative score of the whole distribution of scores. As a teacher, you will need to be using it very often in describing the performance of your students in tests and examinations.

In statistics, the three most common of all the measures available for use are mean, median and mode. Let us discuss them in that order.

3.5.1 The Mean

This is otherwise called the arithmetic average. It is the sum of the scores in a distribution divided by the total number of scores. The formula is $\sum X/N$ where $\sum X$ is the sum of scores, N is the total number of scores $\overline{X}$ is the mean.

Example 17.5:

The scores of ten students in a test are as follows: 40, 55, 60, 30, 50, 48, 70, 85, 72, 65. Find the mean.

To find the mean, we will add all the scores $= \sum X$ and divide by 10 $=$ N i.e. 40+55+60+30+50+48+70+85+72+65.

$\therefore \sum X = 575$. So, $\overline{X} = \sum X/N$ = 575/10 = **57.5**

The mean can also be calculated from frequency distribution. In this case, we use the formula: $\sum FX/\sum F$, where $\sum FX$ is the sum of the products of f and x and $\sum F$ is the sum of the frequencies.

Example 17.6:

Find the mean of the scores below:

S/N	X	F	FX
1.	30	2	60
2.	20	4	80
3.	15	4	60
4.	25	3	75
5.	10	8	85
6.	8	2	16
7.	5	6	30
8.	21	2	42
9.	12	1	12
10.	24	5	120
		37	**575**

(i)   Complete the table by finding the corresponding FX i.e. FXX;
(ii)   Add up F to find $\sum$F;
(iii)   Add up FX to get $\sum$FX;
(iv)   Divide $\sum$FX by $\sum$F = $\sum$FX/$\sum$F = 575/37 = 15.5

The mean can also be calculated when grouped frequency distribution is given.

Example 17.7:

Use the data given below to calculate the mean:

Class Interval	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 –54	55 – 59	60 – 64
Frequency	2	5	6	7	10	6	3	2

(i)   Complete the table by getting the mid-points X, and FX;
(ii)   Use the same formula $\overline{X} = \sum$FX/$\sum$F.

S/N	Class Interval	Mid-point (X)	F	FX
1	60 – 64	62	2	124
2	55 – 59	57	3	171
3	50 – 54	52	6	312
4	45 – 49	47	10	470
5	40 – 44	42	7	294
6	35 – 39	37	6	222
7	30 – 34	32	5	160
8	25 – 29	27	2	54
			47	**1807**

$\Rightarrow \overline{X}$ =   1807/41   =   44.07

You have seen that the mean can be calculated from both grouped and ungrouped data, using different methods. One of these methods is called the assumed mean method. It is called the short-cut.

Example 17.8:

Find the mean using the data on e.g. 17.7.

S/N	Class Interval	Mid-point (X)	F	X^1	FX^1
1	60 – 64	62	2	4	8
2	55 – 59	57	3	3	9
3	50 – 54	52	6	2	12
4	45 – 49	47	10	1	10
5	40 – 44	42	7	0	0
6	35 – 39	37	6	–1	–6
7	30 – 34	32	5	–2	–10
8	25 – 29	27	2	–3	–6
			47		**17**

(i)   Take away group mark as the assumed mean, and code it 0 as shown in column X^1.

(ii)   Code every other mark above from 1, 2, 3 etc. and below –1, –2, etc.

(iii)   Find the FX^1 and sum up.

(iv)   Use the formula $AM + (\sum FX^1/\sum F)^i = \overline{X}$.

$\Rightarrow \overline{X}$ $=$ $42 + (17/41)$ $=$ $42 + + 2.073$ $=$ 44.073

          $=$ **44.07**

3.5.2   The Median

This is the score in the distribution above and below which 50% of the scores lie. It is the middle score which divides the set of scores into two equal halves. In order to get the median, the scores must be arranged in an ordering –ascending or descending.

Example 17.9:

Find the median of the sets of scores:

(a) 9, 7, 15, 10, 11, 8, 2, 4, 3.
(b) 5, 9, 8, 7, 3, 2, 4, 6, 5, 8.

In example (a), simply arrange in ascending order. By this, we have: 2, 4, 5, 7, 8, 9, 10, 11, 15. By counting, the middle number, which is <u>8</u> is the median.

In example (b), you will notice that the number is even. You will therefore arrange in order, by counting, the two middle numbers are taken, added and divided by two.

We have:

        2, 3, 4, 5, <u>5, 6</u>, 7, 8, 8, 9.

The median is $\dfrac{5+6}{2}$ $=$ $\dfrac{11}{2}$ $=$ 5.5

When grouped data are given, the median is calculated using the formula $\ddot{X} = L + \dfrac{(N/2 - cfb)^i}{fw}$

where   L is the lower boundary of the median class;
        N is the number of scores;
        cfb is the cumulative frequency below the median class;
        fw is the frequency within the median class.

Example 17.10:

Use the data below to find the median:

S/N	Class Interval	F	FX
1.	85 – 89	1	52
2.	80 – 84	2	51
3.	75 – 79	3	49
4.	70 – 74	5	46
5.	65 – 69	7	41
6.	60 – 64	8	34
7.	55 – 59	10	26
8.	50 – 54	6	16
9.	45 – 49	5	10
10.	40 – 44	4	5
11.	35 – 39	0	1
12.	30 – 34	1	1
		52	

i. $N/2 = 52/2 = 26$

ii.   Find the class where 26 lies in the cummulative frequency i.e. 55 – 59. This is the median class.

iii. $\ddot{X} = L + \dfrac{(N/2 - cfb)^i}{fw}$ $= 54.5 + \dfrac{(26 - 10)^5}{10}$

$= 54.5 + \dfrac{(10)5}{10} = 54.5 + 5$

$= \mathbf{59.5}$

3.5.3   The Mode

This is the most frequently occurring score or scores in a distribution. It is the most frequent score which can be easily determined by inspection. But in some distributions, you may have two modes. This is called bimodal; any distribution with more than two modes is called multi-modal.

Now, let us look at how to find the modes in the examples below:

Example 17.11:

Find the mode in the distribution below:

20, 30, 21, 45, 30, 25, 33, 35, 30, 22, 29, 30.

By inspection, you will see that 30 appeared 4 times. It is the mode because no other score appeared up to that.

Example 17.12:

Find the mode in the frequency table given below:

X	10	9	8	7	6	5	4	3	2	1
F	1	2	4	5	8	6	4	3	1	1

Again, by inspection, you will see that the highest occurring frequency in the above distribution is 8, and the value is 6. Therefore, 6 is the mode.

For a grouped data, the mode is calculated using the formula below:

$$\ddot{X} = L + \left(\frac{d^1}{d^1 + d^2}\right)^i$$

where L is the exact lower limit of the modal class;
d^1 is frequency of the modal class minus frequency of the class preceding or before the modal class;
d^2 is frequency of the modal class minus frequency of the class immediately after the modal class.

Example 17.13:

Find the mode in the frequency table given below:

S/N	Class Interval	F
1.	85 – 89	3
2.	80 – 84	3
3.	75 – 79	8
4.	70 – 74	10
5.	65 – 69	12
6.	60 – 64	7
7.	55 – 59	5
8.	50 – 54	2

i.   Locate the modal class i.e., 65 – 69.

ii.   Using the formula $L + \left(\frac{d1}{d^1 + d^2}\right)^i$
= 2
where L = 64.5, i = 5, $d^1 = 12 – 7 = 5$, $d^2 = 12 – 10$,

iii. $\ddot{X}$ = $64.5 + \left(\frac{5}{5 + 2}\right)^5$ $64.5 + (\underline{5})^5$
                                                                                      7

$$= \quad 64.5 + 3.571 \quad = \quad \textbf{68.07}$$

Self Assessment Exercise 17.3:

i.   Define mean, median and mode.

ii.   Find the mean, median and mode of the distribution given below:

10, 7, 8, 9, 6, 9, 3, 2, 9, 5, 1.

4.0   CONCLUSION

You have noticed that data by themselves convey little or no meaning until they are summarised and described. Some methods of representing data have been presented and the measures of central tendency, which form the central reference value that is usually close to the point of greatest concentration of the measurement, and which may in some sense be thought of typify the whole set, have also been presented. In the next unit, we shall look at other statistical measures.

5.0   SUMMARY

In this unit, you have been able to go through the other methods of representing data which you started in unit sixteen of this module. You have seen that the pie chart uses a circle to represent a set of data or groups of items. In other words, it can be used for both discrete and continuous data. You also went through the histogram, which is made up of rectangular bars of equal width joined to one another. It is used for continuous data. The frequency polygon is a line graph plotted using the frequencies against the mid-points of the class intervals. The ogive uses the cumulative frequencies against the exact class boundaries. We have two types of ogives – 'less than' ogive and 'greater than' ogive.

You have equally worked through the measures of central tendency. The three measures are the mean, the median and the mode. You have seen how to calculate these measures. In the next unit, we shall look at other measures.

6.0   TUTOR MARKED ASSIGNMENT

Find the mean, the median and the mode of the data given below;

Class Interval	15 – 19	20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 – 64	65 – 69	70 – 74
Frequencies	1	2	3	4	5	6	8	4	3	2	1	1

Answer to SAE Question 17.1

Registration	=	$5/30 \times 360^0$	=	60^0
Course material	=	$10/30 \times 360^0$	=	120^0
Examinations	=	$5/30 \times 360^0$	=	60^0
Diskettes / CDs	=	$1/30 \times 360^0$	=	12^0
Note books	=	$2.5/30 \times 360^0$	=	30^0
Typing of assignments	=	$1.5/30 \times 360^0$	=	18^0
Transportation	=	$3/30 \times 360^0$	=	36^0
Stationeries	=	$2/30 \times 360^0$	=	24^0
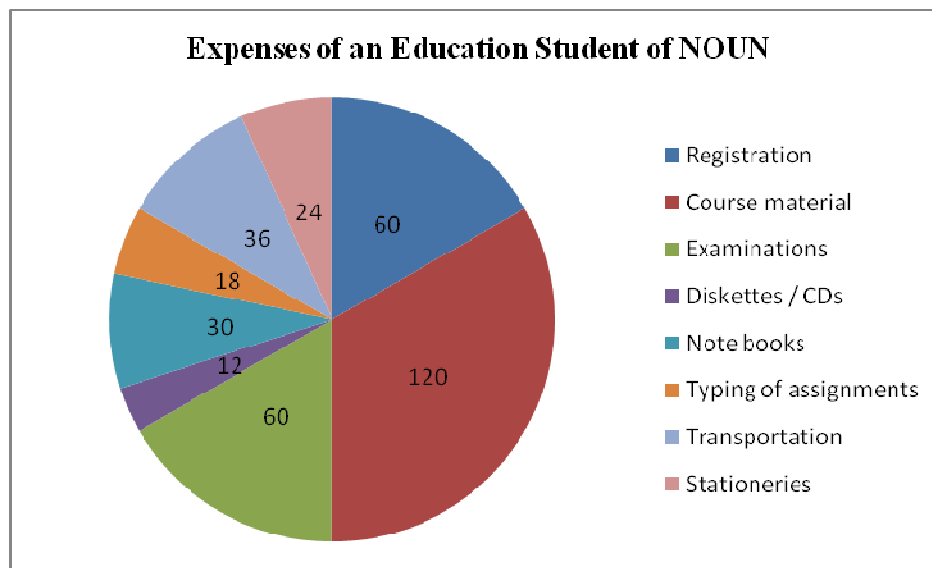
Pie Chart

Answer to SAE Question 17.2

S/N	Class Interval	Class boundaries	F	Cf	Mid-point
1	10 – 12	9.5 – 12.5	2	2	11
2	13 – 15	12.5 – 15.5	4	6	14
3	16 – 18	15.5 – 18.5	6	12	17
4	19 – 21	18.5 – 21.5	10	22	20
5	22 – 24	21.5 – 24.5	7	29	23
6	25 – 27	24.5 – 27.5	12	41	26
7	28 – 30	27.5 – 30.5	8	49	29
8	31 – 33	30.5 – 33.5	5	54	32
9	34 – 36	33.5 – 36.5	0	54	35
10	37 – 39	36.5 – 39.5	4	58	38
11	40 – 42	39.5 – 42.5	3	61	41
12	43 – 45	42.5 – 45.5	1	62	44

Mid-points

Frequency Polygon

70

60

50

F

40

30

20

10

9.5 12.5 15.5 18.5 21.5 24.5 27.5 30.5 33.5 36.5 39.5 42.5 45.5

Real Class boundaries   Ogive
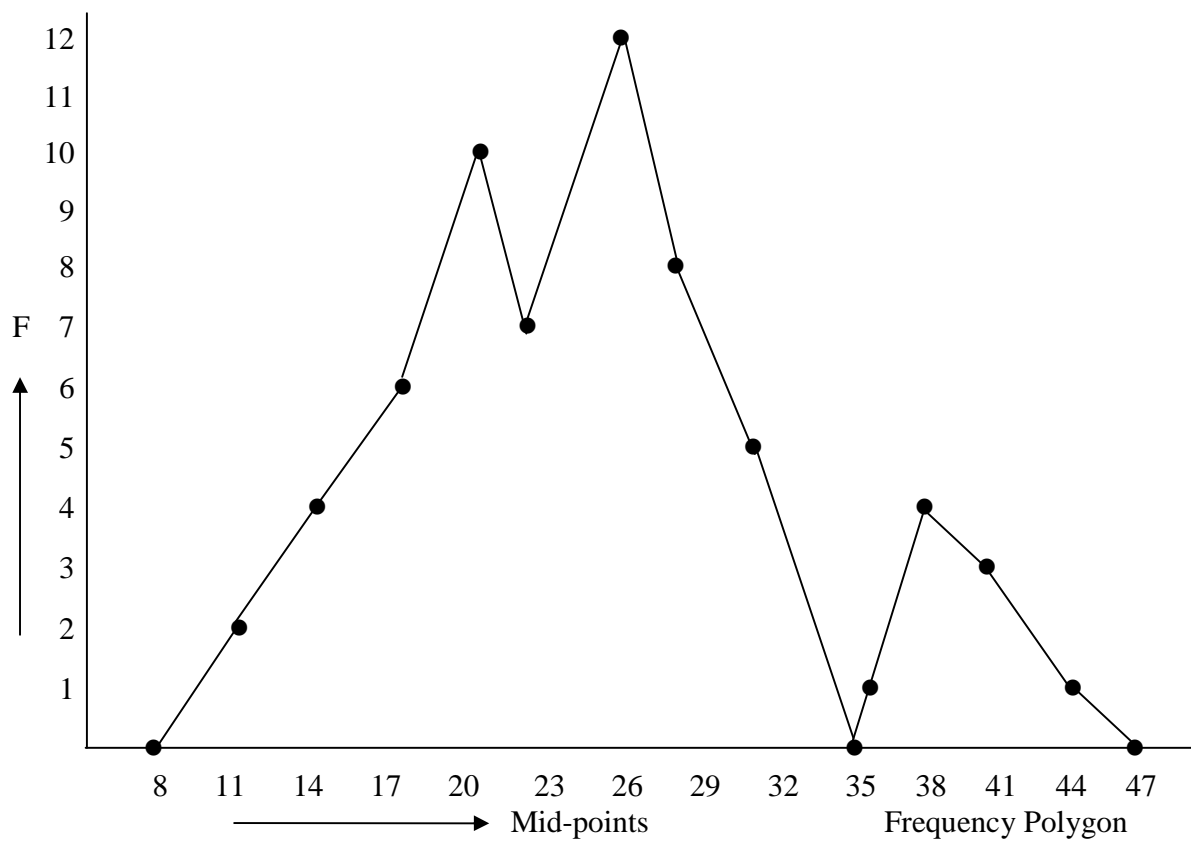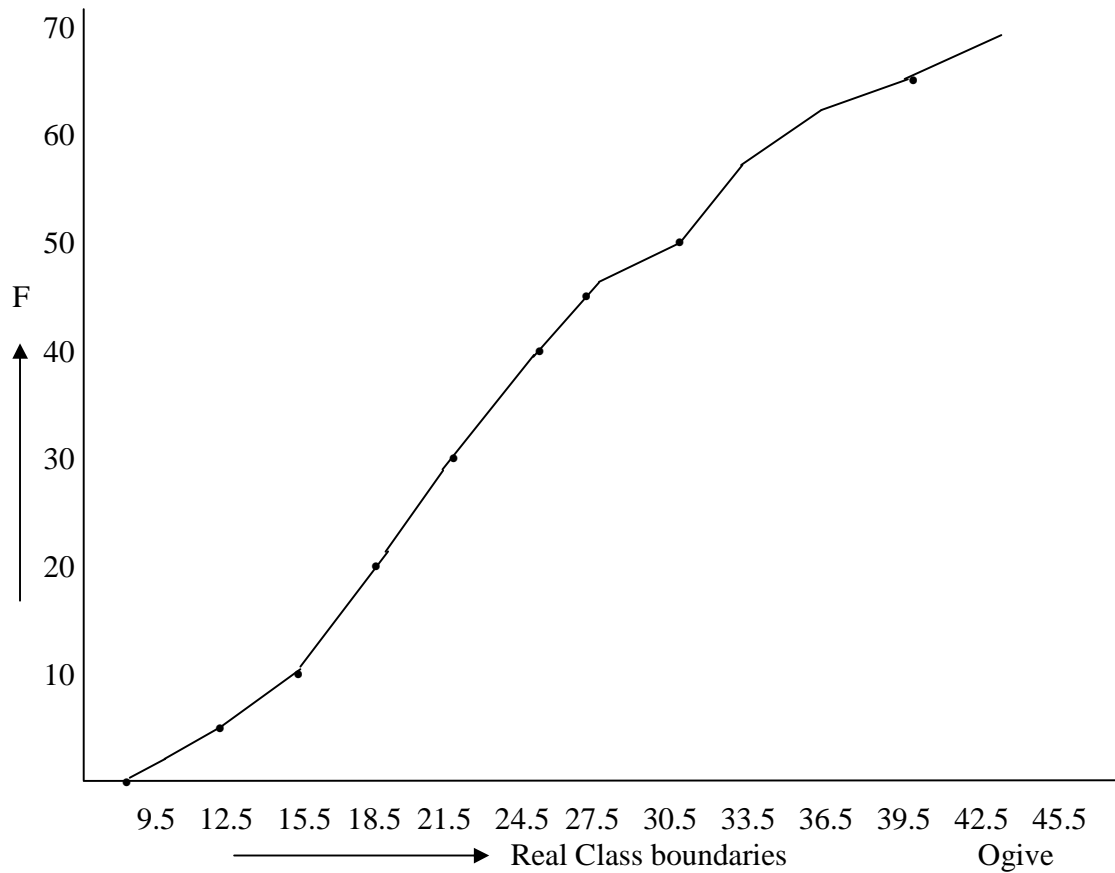
Answer to SAE Question 17.3

i.   Mean is the sum of the scores in a distribution divided by the total number of scores.
       Median is the middle score which divides the set of scores into two equal halves.
       Mode is the most frequently occurring score or scores in a distribution.

ii.   10, 7, 8, 9, 6, 9, 3, 2, 9, 5, 1.

       (a) Mean   = $\dfrac{\sum X}{N}$ = $\dfrac{10+7+8+9+6+9+3+2+9+5+1}{11}$ = $\dfrac{69}{11}$

                                      =   **6.27**

       (b) The middle number is **7**

       (c) Mode: The highest occurring number is **9**.

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7.0   REFERENCES AND FURTHER READINGS

Anaekwe, M.C. (2002). Basic Research Methods and Statistics in Education and Social Sciences. Enugu: Podiks Printing and Publishing Company.

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UNIT 18   MEASURES OF VARIABILITY OR SPREAD

Table of Contents

1.0   INTRODUCTION

In the last unit, you worked through the measures of central tendency. In addition to those measures, researchers are also interested to know how the scores are spread or scattered in the distribution.

So the measures of variability indicate the degree to which a set of scores differs from each other in the distribution. These measures present a measure of homogeneity within the group of scores.

In this unit, we shall look at the range, the quartiles, the percentiles, the variance and the standard deviation.

2.0   OBJECTIVES

After working through this unit, you will be able to:

(i)   find the range in a given set of scores;
(ii)   explain and find the quartiles in a distribution;
(iii)   find the percentiles in a given set of scores;
(iv)   calculate the variance in a given set of scores;
(v)   calculate the standard deviation in a distribution.

3.0 MAIN CONTENT

3.1 The Range

This is the simplest and crudest measure of variability which measures the distance between the highest and the lowest scores in a distribution of scores. It is calculated by subtracting the lowest score from the highest score in the distribution of scores, plus one.

Example 18.1:

Find the range of the scores below:

30, 45, 20, 32, 70, 85, 90, 44, 60.

You will notice that the lowest score is 20 and the highest score is 90. So, $X_h - X_L + 1 = 90 - 20 + 1 = 71$. The range is 71.

You would have seen that the range is affected by the two extreme scores. Therefore, it is an unstable and unreliable method of determining the spread of scores. Because of this limitation, it is seldomly used as an indicator of the spread.

3.2 The Quartiles

These are score points or values which subdivide a given distribution into four equal parts. In other words, the number of scores in anyone of the four groups is equal to the number of scores in any other of the remaining three groups.

There are only three quartiles for any given distribution. These are the first quartile Q_1, second quartile Q_2 and third quartile Q_3. This can be illustrated below:

$$\vdash \quad \overset{1}{\mid} \quad \overset{2}{\mid} \quad \overset{3}{\mid} \quad \overset{4}{\mid} \quad \dashv$$
$$X \quad\quad Q_1 \quad\quad Q_2 \quad\quad Q_3 \quad\quad Y$$
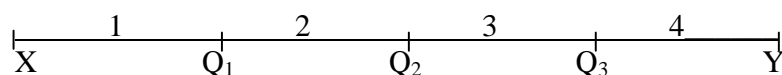
3.2.1 Calculation of the Quartiles

The quartiles can be calculated in a grouped data using the formula $Q_i = L + \{i\dfrac{(N/4) - cfb)}{fw}\}^c$

Where
i	=	1, 2, 3, (i.e. the quartiles)
N	=	$\sum f$ = sample size
L	=	lower class boundary of the quartile class
cfb	=	cummulative frequency below the quartile class
fw	=	frequency of the quartile class
c	=	class interval size.

Example 18.2:

Find Q_1 and Q_3 in the distribution below:

S/N	Class Interval	F	
1.	50 – 54	1	34
2.	45 – 49	2	33
3.	40 – 44	2	31
4.	35 – 39	5	29 ←
5.	30 – 34	8	24
6.	25 – 29	6	16
7.	20 – 24	4	10 ←
8.	15 – 19	3	6
9.	10 – 14	2	3
10.	5 – 9	1	1
		34	

Step   (i)   Find the cumulative frequencies (CF)
       (ii)   Divide 34 by 4 = 34/4 = 8.5
       (iii)   Apply the formula $Qi = L + \dfrac{i(N/4) - cfb)^c}{fw}$

For Q_1:   8.5 lies in the class 20 – 24.

∴ 20 – 24 is the quartile class.

So, L = 19.5, fw = 4, cfb = 6.

Then, $Q_1 = L + \dfrac{(N/4 - cfb)^c}{fw}$ = $19.5 + \dfrac{(8.5 - 6)^5}{4}$ = $19.5 + \dfrac{(2.5)^5}{4}$

          = $19.5 + 3.125$ =   **22.625**

For Q3, $Q_3 = L + \dfrac{(N/4 - cfb)^c}{fw}$ =   (35 – 39 in the class)

        $34.5 + \dfrac{(3 \times 8.5 - 24)^5}{5}$ = $34.5 + \dfrac{(1.5)^5}{5}$

          = $34.5 + 1.5$ =   **36.0**

3.2.2   Interquartile Range

In the last subsection, you learnt that the quartiles divide the distribution of scores into four equal parts. The inter-quartile range describes the distance between the first quartile Q_1 and the third quartile Q_3. It shows the scores that are included in the middle 50% or half of the scores in the

distribution. It is found using the formula $Q_3 - Q_1$. For instance, in the example 18.2 above Q_3 = 36.0 and Q_1 = 22.625. The inter-quartile range (I.Q.R.) is $36.0 - 22.625 = 13.775$.

3.2.3   Quartile Deviation or Semi-interquartile Range

The quartile deviation otherwise called semi-inter-quartile range is described as half the value of the inter-quartile range. It is calculated using the formula:

$$\frac{Q_3 - Q_1}{2}$$

For instance, in the example given above, the semi inter-quartile range will be given by:

$$\frac{36.0 - 22.625}{2} \quad = \quad \frac{13.735}{2} \quad = \quad \textbf{6.87}$$

Self Assessment Exercise 18.1:

Find the semi inter-quartile range of the grouped data given below:

S/No.	1	2	3	4	5	6	7	8	9	10
Class Interval	20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	44 – 49	50 – 54	55 – 59	60 – 64	65 – 69
Frequencies	2	2	4	8	10	12	9	7	5	3

3.3   The Percentiles

These are score points along the score line which divide a distribution of scores into hundred subgroups. The subgroups are divided in such a way that they are equal or the same. It is calculated in the same way as the quartiles, but instead of dividing N by 4, you divide by 100. Thus, $Pi = L + \left(i\dfrac{N/100 - cfb}{fw}\right)^c$.

3.3.1   The Deciles

These are score points in a distribution which divide the distribution of scores into Ten equal parts. As in the percentile or quartile the calculation is the same. The formula is:

$$Di \quad = \quad L + \left(i\frac{N/10 - cfb}{fw}\right)^c.$$

Note that $Q_1 = P_{25}$, $Q_2 = D_5 = P_{50}$ and $Q_3 = P_{75}$.

3.4   The Variance (S^2) and the Standard Deviation (S)

These two measures of variability are directly related. They are the most common, the most reliable estimate of dispersion or spread. They give relative measure of the degree to which each score differs from the mean of the distribution. The standard deviation is the square root of the variance. It is widely used than many other statistical operations.

To calculate the variance and standard deviation, the following steps are applied:

i.   Calculate the mean of the scores.

ii.   Subtract the mean from each score or class midpoint (if grouped).

iii.   Square each of the differences or deviations – $(X – \bar{X})^2$ or d^2 or x^2.

iv.   Multiply each square deviation by the corresponding frequency, the result is $f(X – \bar{X})^2$ or fd^2 or fx^2.

v.   Sum up the result in step (iv) above to obtain $\sum f(X – \bar{X})^2$.

vi.   Divide the result of the sum by total number of scores N or the sum of the frequencies i.e. $\frac{\sum f(X – \bar{X})^2}{\sum f}$ or $\frac{\sum f(X – \bar{X})^2}{N}$. This is the variance ($S^2$).

vii.   Find the square root of the variance to obtain the standard deviation (S) i.e.

$$\sqrt{\frac{\sum f(X – \bar{X})^2}{\sum f}} \quad \text{or} \quad \sqrt{\frac{\sum f(X – \bar{X})^2}{\sum f}}. \quad \text{This is the deviation method.}$$

There is also the raw score method otherwise called the machine approach. We shall look at it after the deviation method. Now let us take some examples.

Example 18.3:

Find the variance and standard deviation of the following scores:

S/N	X	F	fX	$(X – \bar{X})$	$(X – \bar{X})^2$	$f(X – \bar{X})^2$
1	11	1	11	–4.97	24.70	24.70
2	12	2	24	–3.97	15.76	31.52
3	13	4	52	–2.97	8.82	35.28
4	14	7	98	–1.97	3.88	27.16
5	15	10	150	–0.97	0.94	9.40
6	16	12	192	0.03	0.00	0.00
7	17	11	187	1.03	1.06	11.66
8	18	6	108	2.03	4.12	24.72
9	19	4	76	3.03	9.18	36.72
10	20	3	60	4.03	16.24	48.72
		60	**958**			**249.88**

Steps: (i)   Find the mean = $\sum fX / \sum f$ =   958/60   =   **15.97**

        (ii)   Find the deviations   = $(X – \bar{X})$

(iii)   Find the square deviations.

(iv) Multiply the square deviations by the frequency to obtain $f(X - \overline{X})^2$.

(v) Find $\sum f(X - \overline{X})^2$ = 249.88

(vi) Divide by $\sum f$ or N to get variance.

(vii) Find the square root.

$$\frac{249.88}{60} = 4.646667$$

$$S^2 = 4.16$$

$$\therefore \sqrt{4.16} = \underline{\textbf{2.04}}$$

You can also use the raw score approach. Let us use the raw score approach for the same set of scores in Example 18.4:

S/N	X	f	fX	X^2	fX^2
1	11	1	11	121	121
2	12	2	24	144	288
3	13	4	52	169	676
4	14	7	98	196	1372
5	15	10	150	225	2250
6	16	12	192	256	3072
7	17	11	187	289	3179
8	18	6	108	324	1944
9	19	4	76	361	1444
10	20	3	60	400	1200
		60	**958**		**15546**

Step:

(i) Complete the composite table as shown.
(ii) For Variance (S^2) use the formula = $\dfrac{(\sum f) \sum fX2 - (\sum fX)^2}{(\sum f)^2}$ or $\dfrac{N\sum fX^2 (\sum fX)^2}{N^2}$

Substituting, we have: $S^2 = \dfrac{60 \times 15546 - 958^2}{3600}$ or $\dfrac{14996}{3600}$

= **4.165**

For standard deviation, S. Find the square root of the variance i.e. $\sqrt{4.165}$ = **2.04**

Self Assessment Exercise 18.2:

Find the variance and standard deviation of the following:

S/No.	1	2	3	4	5	6	7	8	9	10
Class Interval	3	4	5	6	7	8	9	10	11	12
Frequencies	2	4	8	9	10	7	5	3	2	1

Sometimes, you may be given grouped scores. The same method is used. The only different is that you have to find and use the mid-points of the groups or class intervals as your score X.

4.0   CONCLUSION

In this unit, you have gone through the other measures which are used to determine the extent of spread or variability in a given set of scores. They represent a measure of homogeneity within a group of scores. The standard deviation is applied in most other statistical tests.

5.0   SUMMARY

You have seen that the range is a measure of the distance between the highest and the lowest scores in a distribution. The quartiles are score points which divide the distribution into four equal parts. We have Q_1, Q_2 and Q_3. The percentiles divide the distribution into hundred equal parts. The deciles divide the distribution into ten equal parts. You have also gone through variance and standard deviation which are the most reliable estimate of dispersion or spread. The standard deviation is the square root of the variance.

In the next unit, we shall be looking at the measures of association.

6.0   TUTOR MARKED ASSIGNMENT

In the data below, find:

(i) The semi inter-quartile range, and
(ii) The standard deviation.

S/No.	1	2	3	4	5	6	7	8	9	10
Class Interval	20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	44 – 49	50 – 54	55 – 59	60 – 64	65 – 69
Frequencies	1	2	4	5	10	8	6	4	3	2

Answer to SAE Question 18.1

S/N	Class Interval	f	cf	
1	20 – 24	2	2	
2	25 – 29	2	4	
3	30 – 34	4	8	
4	35 – 39	8	16	← Q1
5	40 – 44	10	26	
6	45 – 49	12	38	
7	50 – 54	9	47	← Q3
8	55 – 59	7	54	
9	60 – 64	5	59	
10	65 – 69	3	62	
		62		

(i) $N/4$ = $62/4$ = **15.5**

(ii) Q_1 = $L + \dfrac{(iN/4 - cfb)^c}{fw}$ = $34.5 + \dfrac{(15.5 - 8)^5}{8}$

= $34.5 + 4.6875$ = 39.1875 = **39.19**

(iii) Q_3 = $L + \dfrac{(iN/4 - cfb)^c}{fw}$ = $34.5 + \dfrac{(3 \times 15.5 - 38)^5}{9}$

= $49.5 + 4.722$ = 54.22 = **54.22**

(iv) Semi inter-quartile range = $\dfrac{Q_3 - Q_1}{2}$ = $\dfrac{54.22 - 39.19}{2}$

= $15.03/2$ = **7.515**

Answer to SAE Question 18.2

S/N	X	f	fX	X^2	fX^2
1	3	2	6	9	18
2	4	4	16	16	64
3	5	8	40	25	200
4	6	9	54	36	324
5	7	10	70	49	490
6	8	7	56	64	448
7	9	5	45	81	405
8	10	3	30	100	300
9	11	2	22	121	242
10	12	1	12	144	144
		51	**351**		**2635**

(iii) For variance (S^2) = $\dfrac{(\sum f) \sum fX2 - (\sum fX)^2}{(\sum f)^2}$

= $\dfrac{51 \times 2635 - (351)^2}{51 \times 51}$ = $\dfrac{11184}{2601}$

= 4.1998847 = **4.3**

(iv) Standard deviation (S) = $\sqrt{4.3}$ = **2.07**

7.0 REFERENCES AND FURTHER READINGS

Anaekwe, M.C. (2002). Basic Research Methods and Statistics in Education and Social Sciences. Enugu: Podiks Printing and Publishing Company.

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UNIT 19   MEASURES OF ASSOCIATION/CORRELATION

Table of Contents

1.0   INTRODUCTION

In the previous units, we have focused on sample scores from one variable or distribution of scores from one variable.

In this unit, you will learn about matched or paired sets of scores. Specifically, measures of association show the degree of relationship between two or more variables.

We shall be looking at some of these measures or the statistics for describing the extent of correlation or 'going together' of some attributes or characteristics possessed by a sample of individuals. This degree of relationship between the attributes or variables is expressed as a coefficient of correlation.

The result of this unit will teach you the most common types of correlation which are Pearson Product Moment and Spearman Rank Order.

2.0   OBJECTIVES

At the end of this unit, you will be able to:

(i)   define correlation;
(ii)   illustrate the scatter-grams of various correlations;
(iii)   calculate the Pearson r;
(iv)   calculate the Spearman rho.

3.0   MAIN CONTENT

3.1   The Concept of Correlation

Correlation refers to the extent or degree of relationship between two variables. The index showing the degree of such relationship between the two variables is called correlation–coefficient.

The value obtained from correlation will help you as a researcher to know whether variations in one set of scores lead to variations in another set of scores. It will also help you to know the extent to which this variation takes place.

Correlation values ranges from –1 to +1. It means that a correlation coefficient of –1 indicates a perfect negative relationship, while +1 shows perfect positive relationship and 0 correlation coefficient implies no relationship at all. Many types of correlation coefficients exist. You can use any type, but this will depend on the following:

(i)   the type of measurement scale in which the variables are;
(ii)   the nature of the distribution (i.e. continuous or discrete);
(iii)   the characteristics of the distribution scores.

3.2   Scatter-grams of Various Correlations

A scatter-gram is a shortened form of scatter diagram. It shows the plots on the Cartesian coordinate plane of two sets of scores of individuals of a sample with respect to two attributes which are usually denoted by X and Y.

i.   **Positive Relationship**: This suggests that individuals having high scores in one variable also have high scores in the other variable. It also implies that those individuals who have low scores in one variable also have low scores in the other variables.
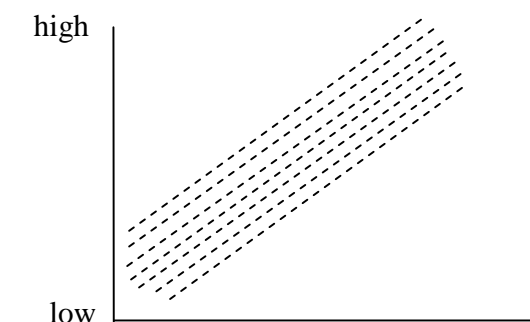
(a) r = Perfect Positive Relationship   (b) r = Moderate Positive Relationship
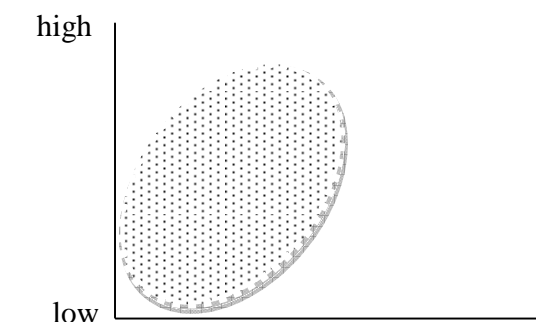
ii.   **Negative Relationship**: As you can see, this is the opposite of positive relationship. It suggests that individuals scoring high on one variable score low on another variable. It also implies that those who score low on one variable score high on the other variable.
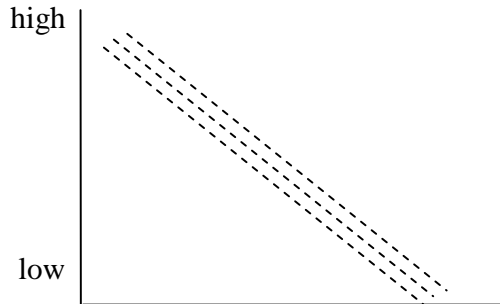
(c) r = Perfect Negative Relationship   (d) r = Moderate Negative Relationship
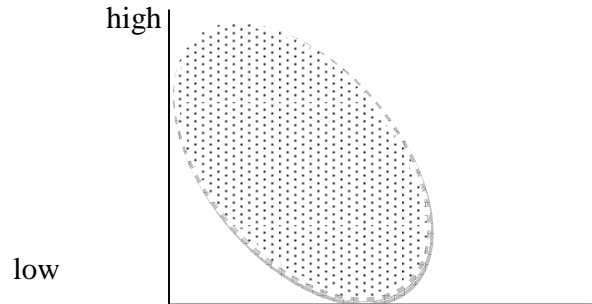
iii.   **Zero Relationship**: This suggests the absence of any relationship. There is no relationship between scores on the two variables.
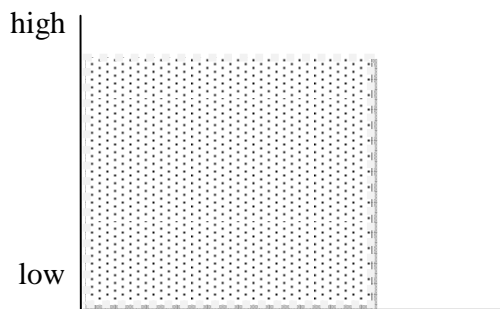
(e) r = No Relationship

3.3   Pearson Product Moment Correlation Coefficient (r)

This type of correlation coefficient, named after the man who developed it, is used when the two sets of data are continuous or interval data. There are two major approaches of calculating the Pearson Product Moment correlation coefficient (r).

The first is the deviations from the mean approach, while the second is the raw scores approach. Let us look at them one after the other.

3.3.1   Calculating Pearson r using Deviations from the Mean

The formula is given by:
$$\frac{\sum(X - \overline{X})(Y - \overline{Y})}{\sqrt{\sum(X - \overline{X})^2 \sum(Y - \overline{Y})^2}} \quad or \quad \frac{\sum xy}{\sqrt{(\sum X^2)(\sum Y^2)}}$$

where $x = X - \overline{X}$, $y = Y - \overline{Y}$

Example 19.1:

Using the data below, calculate the Pearson r.

X	10	11	12	12	13	14	15	15	16	17	17	18	18
Y	5	8	9	4	7	6	8	9	10	10	12	14	13

Step:

i.   Find the mean for X and Y.

ii.   Complete the composite table.

iii.   If $\sum xy = 80.90$, $\sum x^2 = 87.25$, $\sum y^2 = 107.72$. Then $\dfrac{\sum xy}{\sqrt{\sum x^2 y^2}}$ $=$ r

S/N	X	Y	X – X̄ (x)	Y – Ȳ (y)	xy	x^2	y^2
1	10	5	–4.5	–3.8	17.10	20.25	14.44
2	11	8	–3.5	–0.8	2.80	12.25	0.64
3	12	9	–2.5	0.2	–0.50	6.25	0.04
4	12	4	–2.5	–4.8	12.00	6.25	23.04
5	13	7	–1.5	–1.8	2.70	2.25	3.24
6	14	6	–0.5	–2.8	1.40	0.25	7.84
7	15	8	0.5	–0.8	–0.40	0.25	0.64
8	15	9	0.5	0.2	0.10	0.25	0.04
9	16	10	1.5	1.2	1.80	2.25	1.44
10	17	10	2.5	1.2	3.00	6.25	1.44
11	17	12	2.5	3.2	8.00	6.25	10.24
12	18	14	3.5	5.2	18.20	12.25	27.04
13	18	13	3.5	4.2	14.70	12.25	17.64
	188	**115**			**80.90**	**87.25**	**107.72**
	14.5	**8.8**					

r $=$ $\dfrac{80.90}{\sqrt{87.25 \times 107.72}}$ $=$ $\dfrac{80.90}{\sqrt{9,398.57}}$ $=$ $\dfrac{80.90}{96.945}$

r $=$ **0.83**

3.3.2 Calculating Pearson r using the Raw Score Method

The formula is given by r $=$ $\dfrac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X^2) - (N\sum Y^2 - (\sum Y)^2}}$

where $x = X - \overline{X}$, $y = Y - \overline{Y}$

Example 19.2:

Let us use the same data in example 19.1.

X	10	11	12	12	13	14	15	15	16	17	17	18	18
Y	5	8	9	4	7	6	8	9	10	10	12	14	13

Steps:
i.   Complete the composite table.

ii.   If N = 13, $\sum X = 188$, $\sum Y = 115$, $\sum XY = 1744$, $\sum X^2 = 2806$ and $\sum Y^2 = 1125$, then:

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X^2) - (N\sum Y^2 - (\sum Y)^2}}$$

S/N	X	Y	XY	X^2	Y^2
1	10	5	50	100	25
2	11	8	88	121	64
3	12	9	108	144	81
4	12	4	48	144	16
5	13	7	91	169	49
6	14	6	84	196	36
7	15	8	120	225	64
8	15	9	135	225	81
9	16	10	160	256	100
10	17	10	170	289	100
11	17	12	204	289	144
12	18	14	252	324	196
13	18	13	234	324	169
$\sum$	**188** **14.5**	**115** **8.8**	**1744**	**2806**	**1125**

$$r = \frac{13 \times 1744 - 188 \times 115}{\sqrt{13 \times 2806 - 188^2 \times 13 \times 1125 - 115^2}}$$

$$= \frac{22672 - 21620}{\sqrt{36478 - 35344 \times 14625 - 13225}}$$

$$= \frac{1052}{\sqrt{1134 \times 1400}}$$

$$= \quad \frac{1052}{1260} \quad = \quad \mathbf{\underline{0.83}}$$

You can see that the two approaches give the same result. This is because the formula of the raw scores method is derivable from the formula of the deviations from the mean method. You will have to note that when the scores are large and the means of X and Y are whole numbers, the deviations from the mean method becomes simper to handle. But when the means of X and Y are not whole numbers the raw score method is preferred.

Self Assessment Exercise 19.1:

Use any method to calculate the Pearson r of the data:

S/N	1	2	3	4	5	6	7	8	9	10
X	51	44	70	32	65	67	19	71	45	80
Y	49	41	45	31	50	61	11	64	21	75

3.4   Spearman Rank Order Correlation Coefficient – rho

This correlation coefficient was developed independently by Spearman and Brown. This is why it is sometimes referred to as Spearman-Brown Rank Order Correlation Coefficient.

It is more popularly known as Spearman rho, because Spearman was the first to publish it. It is an approximation of the Pearson r. It is used when the scores in each variable are ranked in the same direction, with respect to magnitude.

So, in the use of Spearman rho, ranking is emphasised. It must be done and correctly too.

3.4.1   Calculation of Spearman Rank Order Correlation

The formula is given by: rho $= \quad 1 - \dfrac{6 \sum D^2}{N(N^2 - 1)}$

Example 19.3:

Calculate the rho of the data presented below:

S/N	1	2	3	4	5	6	7	8	9	10
X	51	44	70	32	65	67	19	71	45	80
Y	49	41	45	31	50	61	11	64	21	75

S/N	X	Y	RX	RY	D	D²
1	51	49	6	5	1	1
2	44	41	8	7	1	1
3	70	45	3	6	–3	9
4	32	31	9	8	1	1
5	65	50	5	4	1	1
6	67	61	4	3	1	1
7	19	11	10	10	0	0
8	71	64	2	2	0	0
9	45	21	7	9	–2	4
10	80	75	1	1	0	0
∑						**10**

Steps:

i.   Complete the composite table by getting the ranks and the differences between the ranks.

ii.   Apply the formula: $\text{rho} = 1 - \dfrac{6\sum D^2}{N(N^2 - 1)}$

$$\text{rho} = 1 - \frac{6 \times 18}{10(10^2 - 1)} = 1 - \frac{108}{10 \times 99} = 1 - \frac{108}{990}$$

$$= 1 - 0.109 = \underline{\textbf{0.891}}$$

3.5   Point Biserial Correlation Coefficient – rpbi

You have worked through the Pearson r and Spearman rho. Let us close this unit with the point biserial correlation coefficient which is used when one variable has dichotomized values. Typical examples of variables which can use rpbi are scores and sex.

Example 19.4:

S/N	1	2	3	4	5	6	7	8	9	10	11	12
X	10	15	11	13	12	18	20	14	16	17	09	07
Y	G	B	G	B	G	G	B	G	B	B	B	B

The formula for this is given by: $\text{rpbi} = \dfrac{\overline{X}p - \overline{X}q}{St}\sqrt{pq} = \dfrac{\overline{X}p - \overline{X}t}{St}\sqrt{p/q}$

where $\overline{X}p$ =   mean score of the continuous variable of the subgroup that belongs to the natural dichotomy p.

$\overline{X}q$ =   mean score of the continuous variable of the subgroup that belongs to the natural dichotomy q.

St =   standard deviation of the total scores for the whole group on the

continuous variable.

p = proportion of the number of members in subgroup p.

q = proportion of the number of members in subgroup q.

Now, let us look at the steps you can follow:

i. Find $\overline{X}p$ = mean for the proportion of boys and the group.

= $\dfrac{15 + 13 + 20 + 16 + 17 + 09 + 07}{7}$ = $\dfrac{97}{7}$ = **13.86**

ii. Find $\overline{X}q$ = mean for the proportion of girls in the group.

= $\dfrac{10 + 11 + 12 + 18 + 14}{5}$ = $\dfrac{65}{5}$ = **13.0**

iii. Find p = 7/12 = 0.58

iv. Find q = 5/12 = 0.42.

v. Find St.

S/N	X	X – X	$(X – \overline{X})^2$
1	10	–3.5	12.25
2	15	1.5	2.25
3	11	–2.5	6.25
4	13	–0.5	0.25
5	12	–1.5	2.25
6	18	4.5	20.25
7	20	6.5	42.25
8	14	0.5	0.25
9	16	2.5	6.25
10	17	3.5	12.25
11	09	–4.5	20.25
12	07	–6.5	42.25
$\sum$	162		167.00
$\overline{X}$	13.5		

St = r $\sqrt{\dfrac{\sum(X – \overline{X})^2}{n}}$ = $\sqrt{\dfrac{167}{12}}$ = $\sqrt{13.92}$

= **3.73**

$$\therefore \quad r_{pbi} \quad = \quad \frac{\overline{X}p - \overline{X}q}{S_t} \sqrt{pq} \quad = \quad \frac{13.86 - 13.0}{3.73} \sqrt{0.58 \times 0.42}$$

$$= \quad 0.2305563 \times 0.4935585$$
$$= \quad 0.1137963 \qquad = \qquad \mathbf{\underline{0.11}}$$

Self Assessment Exercise 19.2:

Find the rpbi of the following data:

S/N	1	2	3	4	5	6	7	8	9	10	11	12	13
X	60	40	55	20	70	35	48	15	30	57	65	25	30
Y	G	B	B	G	B	G	B	G	B	G	B	G	G

4.0   CONCLUSION

A very good number of research studies tend to determine the nature and scope of relationships which exist between two or more variables being investigated.

In this unit, you have seen that the degree of relationship which exists between variables is referred to as correlation. You have also noted that the statistical index of measuring the relationship is called correlation coefficient.

This correlation coefficient presents a picture of how a change in one variable results in a change in the corresponding correlated variable. The result of the correlation tests can be used for predictive purposes. But they cannot be used for establishing a cause-effect relationship between two variables.

5.0   SUMMARY

In this unit, you have learnt that correlation is the extent or degree of relationship between two variables while the index showing the degree of such relationship between the two variables is called correlation coefficient. Correlation values range from –1 to +1. Scatter-grams of different types of relationships were shown. Pearson Product Moment Correlation Coefficient otherwise called Pearson r was also discussed with the two methods for the computation. These are the deviation and the raw score methods. The methods for calculating the Spearman rho and the Point Biserial Correlation (rpbi) were discussed in detail. The next unit will take us to the test of hypotheses to complete the module.

6.0   TUTOR MARKED ASSIGNMENT

i.   Using any convenient correlation method, calculate the correlation coefficient of the data given below:

S/N	1	2	3	4	5	6	7	8	9	10	11	12
X	31	24	50	12	45	47	09	51	25	60	15	10
Y	29	21	25	11	30	41	01	44	11	55	05	03

ii.   What is the interpretation of the correlation results?

Answer to SAE Question 19.1

S/N	X	Y	XY	X^2	Y^2
1	51	49	2499	2601	2401
2	44	41	1804	1936	1681
3	70	45	3150	4900	2025
4	32	31	992	1024	961
5	65	50	3250	4225	2500
6	67	61	4087	4489	3721
7	19	11	209	361	121
8	71	64	4544	5041	4096
9	21	21,	941	2025	441
10	75	75	6000	6400	5625
$\sum$	**544**	**448**	**27476**	**33002**	**23572**

$N = 10, \sum = 544, \sum Y = 448, \sum XY = 27476, \sum X^2 = 33002, \sum Y^2 = 23572.$ Then,

$$r = \frac{N\sum XY - \sum X \sum Y}{\sqrt{N\sum X^2 - (\sum X^2) - (N\sum Y^2 - (\sum Y)^2}}$$

$$= \frac{10 \times 27476 - 544 \times 448}{\sqrt{(10 \times 33002 - 544^2)(10 \times 23572 - (448)^2}}$$

$$= \frac{274760 - 243712}{\sqrt{(330020 - 295936)(235720 - 200704)}}$$

$$= \frac{31050}{\sqrt{34084 \times 35016}} = \frac{31050}{34546.857}$$

$$= 0.8987793 = \underline{\mathbf{0.90}}$$

Answer to SAE Question 19.2

S/N	X	$X - \overline{X}$	$(X - \overline{X})^2$
1	60	17.7	313/29
2	40	–2.3	5.29
3	55	12.7	161.29
4	20	–22.3	497.29
5	70	27.7	767.29
6	35	–7.35	53.29
7	48	5.7	32.49
8	15	–27.3	745.29
9	30	–12.3	151.29
10	57	14.7	216.09
11	65	22.7	515.29
12	25	–17.3	299.29
13	30	–12.3	151.29
$\sum$	**162**		**3908.77**
$\overline{X}$	**42.3**		

vi. $\overline{X}p$ $= \dfrac{40 + 55 + 70 + 48 + 30 + 65}{6}$ $=$ $\dfrac{308}{6}$ $=$ **51.33**

vii. $\overline{X}q$ $= \dfrac{60 + 20 + 35 + 15 + 57 + 25 + 30}{7}$ $=$ $\dfrac{242}{7}$ $=$ **34.57**

viii. p = 6/13 = 0.46

ix. q = 7/13 = 0.54.

St $=$ r $\sqrt{\dfrac{\sum(X - \overline{X})^2}{n}}$ $=$ $\sqrt{\dfrac{3908.77}{13}}$ $=$ $\sqrt{300.67}$

$=$ **17.34**

∴ rpbi $=$ $\dfrac{\overline{X}p - \overline{X}q}{St}\sqrt{pq}$ $=$ $\dfrac{51.33 - 34.57}{17.34}\sqrt{0.46 \times 0.54}$

$=$ $=$ $\dfrac{16.76}{17.34}\sqrt{0.2484}$

$=$ $\dfrac{16.76}{17.34}$ x 0.4983974

$=$ 0.9665513 x 0.4983974 $=$ 0.4817266 $=$ **0.48**

7.0 REFERENCES AND FURTHER READINGS

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UNIT 20   THE TESTING OF HYPOTHESIS

Table of Contents

1.0   INTRODUCTION

In Module one, you were introduced to the types of hypotheses. In this unit, you will learn how to test the hypotheses using some of the statistical tests.

The purpose of testing a hypothesis is to determine the probability that it is supported by facts. You may test a hypothesis by applying it to already known facts or taking it as a new appeal to experience. This same mental technique to problem-solving is also employed by science and philosophy.

Hypotheses are used as indicators of the realistic answers which researchers have to their stated problems or questions in research. So when hypotheses are tested, the results lead to establishment of new facts or confirmation of old ones. If a hypothesis is successfully verified or tested and confirmed to be true, it is then used to support a theory.

In other words, theories are developed, tested and confirmed in research through the process of hypothesis testing. This leads to the generation or advancement of knowledge. In this unit, you are going to be exposed to the rudiments of the processes involved in testing hypotheses.

2.0   OBJECTIVES

After going through this unit, you will be able to:

(i)   explain the alpha level or level of confidence and degree of freedom;
(ii)   discuss the two types of errors in hypothesis testing;
(iii)   use the t-test to test a given null hypothesis;
(iv)   use the relationship between correlation coefficient and t-test in hypothesis testing;
(v)   use analysis of variance to test hypothesis;
(vi)   use chi-square to test hypothesis;
(vii)   explain the meaning of one-tailed and two-tailed tests.

3.0   MAIN CONTENT

3.1   Selection of the Level of Significance or Alpha Level

In proposing your hypothesis, you must include a confidence limit, otherwise called alpha level (α) or significance level.

In most researches in education, two alpha levels are used. These are 5% (0.05) and 1% (0.01). If you choose 5% in a particular study, the implication is that if your study is replicated 100 times, the same outcome will occur 95 out of 100, and 5 out of 100 may vary due to chance. If it is 1% (0.01) level of significance, it means that if your study is replicated 100 times, you are sure 99 out of 100 will be correct while 1 out of 100 may vary due to chance factors. This is a more rigorous confidence level.

At this point, you need to note that when you test a hypothesis, you are only dealing with probability of something being true or false. Hypothesis testing helps you to make predictions and not to establish causation. It does not provide absolute proof. In other words, a hypothesis cannot be proved absolutely true or false.

3.2   Degrees of Freedom

This is the number of observations which are free to vary when certain restrictions have been placed on the data being considered. Take for instance, in your class, you ask your students to provide any four numbers which would be added to 4 to add up to 24. In this case, it is fixed, other numbers can vary. But no matter how they vary, 4 must be added to sum up to 24. Therefore, the degree of freedom here is $N - 1$, where N is the total number of choices while 1 is the fixed variable. As we go on, you will see the modal for getting the degrees of freedom for different tests.

3.3   Type I and Type II Errors

When you embark on a research study which involves the testing of hypothesis, the level of significance and the degree of freedom will enable you to take a decision about whether to accept or not to accept (reject) the hypothesis. If the null hypothesis which you have proposed is true and you accept it because your evidence supports it, then you are quite in order. It is correct. But if the null hypothesis is true based on the available evidence and you reject it, it is not correct. It is an error. Thus, the rejection of a true null hypothesis when it should have been accepted is known as Type I error.

On the other hand, if the null hypothesis is false and you accept it, instead of rejecting it, you are also not correct. In other words, the acceptance of a false null hypothesis when it should have been rejected is referred to as Type II error.

You have to note that as you try to minimize type I error by becoming too rigorous, may be you reduce the significance level from 5% to 1%, you stand the chance of making type II error by increasing the level of significance from 1% to 5%.

3.4   Two-tailed and One-tailed Tests

When a hypothesis is stated in such a way that it does not indicate a direction of difference, but agrees that a difference exists, we apply a two-tailed test of significance. Most of the null hypotheses are two-tailed because they do not indicate the direction of difference. They merely state that there is no significant difference between A and B. For instance, there is no significance difference in academic performance between those who went to Federal Government Colleges and those who went to State Schools.

When hypothesis is stated to indicate the direction of difference, it is called a one-tailed test. For example, people who live in high altitude areas perform better in long distance races. People who have stout bodies do better in short-put. Expensive cars are better in performance etc.

3.5   The T-test

The t-test otherwise called the student's t-test is an inferential technique. It was developed by William Gosset in 1908. There are various t-test techniques used for various tests of hypothesis concerning the following:

i.   difference between population and sample means;
ii.   difference between two independent samples' means;
iii.   difference between matched samples' means;
iv.   the significance of Pearson r;
v.   difference between correlated coefficients;
vi.   difference between variances that are correlated.

We are not going to treat all these in this course, but during your master's degree programme, you will have all or most of them. For this unit, we shall take only three methods. Before we go into that, you will have to note that there are conditions for the use of t-tests. These are:

i.   there must be two groups to be compared;
ii.   the population from which the samples are drawn must be normally distributed;
iii.   the population variances are homogenous;
iv.   the samples are independent or randomly drawn from the population;
v.   the variables have continuous values;
vi.   suitable for both large and small samples (but not less than ten).

Note that any sample size less than 30 is regarded as small, but when the sample size is more than 30, it is regarded as large. The procedure for carrying out z-test is the same to that of t-test. While z-test is specifically used for large samples, t-test can be used for both small and large samples. When t-test is used for large samples, it approximates to z-test.

3.5.1 Difference between Population and Sample Means

When you want to compare a population and sample means, you will use this mode:

$$t = \frac{\overline{X} - \mu}{S/\sqrt{n-1}}$$

where $\overline{X}$ = sample mean
μ = population mean
S = standard deviation
n = number.

For instance, you are given that the mean achievement score of all SS.I students in Ihitte/Uboma, in an English standardized test is 55%. A teacher conducted a study to verify this claim. He used 25 SS.I students in that locality. He drilled them on the different aspects of English syllabus for SS.I, for about eight weeks. At the end, the teacher administered the English test on the 25 students. His results are 59.85 as mean and 8.50 as standard deviation.

The first step is to propose a hypothesis (H_0). You can say the sample mean of 59.85 is not significantly grater than the population mean of 55, at an σ level of 0.05 or you can say that there is no significant difference between the sample mean of 59.85 and population mean of 55.

$$t = \frac{\overline{X} - \mu}{S/\sqrt{n-1}}$$

where $\overline{X}$ = 59.85, μ = 55, S = 8.50 and n = 25

$$\therefore \quad t = \frac{59.85 - 55}{\dfrac{8.5}{\sqrt{25-1}}} \quad = \quad \frac{4.85 \times \sqrt{24}}{8.50}$$

$$= \quad 0.57 \times 4.899 \quad = \quad \underline{\textbf{2.795}}$$

At this point, you have to take a decision. This will be based on the comparison of the calculated value of t-test and the value of t-test on the table or the critical region.

Now that t_{cal} = 2.795, df = 25 – 1 = 24, alpha level = 0.05

$$\therefore \quad t_{tab} \text{ at } (25 : 0.05) = 2.060.$$

For decision rule, if calculated value is greater than the value in the table or critical value, Reject the null hypothesis. But, if the calculated value is less than the value on the table, Accept H_0.

From this result, t_{cal} is greater than the t_{tab} i.e. 2.795 > 2.060. We therefore reject that there is no significant difference between the population mean and the sample, mean. It implies that there is a significant difference between the two means.

Self Assessment Exercise 20.1:

What do you understand by the following:

(a) $P < 0.05$
(b) degree of freedom
(c) Type I and Type II errors
(d) Two tailed and one tailed test.

3.5.2   Difference between Two Independent Samples' Means

In section 3.5.1, you learnt how to find the t-test of significance when the population mean and the sample mean are given. Most of the times, you will be confronted with a situation where two samples are randomly and independently drawn from a normal population. If the variances of the samples as estimates of the population variance do not differ significantly or are homogenous, we can then say that they have a t-distribution. This is particularly when the samples' sizes are not large. Remember that a large sample size is from 30 and above. The t-statistics which you can use in this case is as follows:

$$t = \frac{\overline{X} - \overline{X}}{\sqrt{\frac{[(n_1-1) S_1^2 + ((n_2-1) S_2^2)] ((n_1+n_2)}{(n_1 + n_2 - 2) n_1 \times n_2}}}$$

where $S1 = \sqrt{\dfrac{\sum(X_1 - \overline{X}_1)^2}{n_1 - 1}}$

Example 20.2:

A teacher wanted to compare the academic performance of two sets of students in his school with a view to finding out whether their mean performances are significantly different. He collected samples of the two sets. His results are shown in the table below:

Set	Mean Performance	Standard deviation	No. of Samples
2005	50%	14.50	80
2006	58%	12.00	75

Solution:

i.   Propose a null hypothesis H_0: There is no significant difference between the mean performances of the students from the two sets.

ii. $$t = \frac{\overline{X} - \overline{X}}{\sqrt{\frac{[(n_1-1) S_1^2 + (n_2-1) S_2^2)] ((n_1+n_2)}{(n_1 + n_2 - 2) n_1 \times n_2}}}$$

$$t = \dfrac{58 - 50}{\sqrt{\dfrac{[(75-1)\,12^2 + (80-1)\,14.5^2)]\,(75+80)}{(75 + 80 - 2)\,75 \times 80}}}$$

$$= \dfrac{8}{\sqrt{\dfrac{[(74)\,144 + (79)\,210.25)]\,(155)}{153 \times 6000}}}$$

$$= \dfrac{8}{\sqrt{\dfrac{(10656 + 16609.75)\,155}{918000}}}$$

$$= \dfrac{8}{\sqrt{\dfrac{27265.75 \times 155}{918000}}}$$

$$= \dfrac{8}{\sqrt{\dfrac{4226191.3}{918000}}}$$

$$= \dfrac{8}{\sqrt{4.6036942}} \qquad = \dfrac{8}{2.1456221}$$

$$= 3.7285224 \qquad = \mathbf{\underline{3.73}}$$

iii. Decision:

$t_{cal} = 3.73$, t_{tab} at $(75+80 - 2 : 0.05/2) = t_{tab}$ at $153 : 0.05$

$t_{cal} = 3.73$. $t_{(153 : 0.025)} = 1.96$

Since t_{cal} is greater than t_{tab}, we reject H_0. It means that there is a significant difference between the mean performances of the two sets of students.

Self Assessment Exercise 20.2:

The result of a researcher's study, to find out if there is a significant difference between the performances of males and females in his class is given below:

Gender	Mean Performance	Standard deviation	No. of Samples
Males	65%	11.50	45
Females	58%	14.20	40

Are the gender-wise performances significantly different?

3.5.3   Difference between Two-matched Sample Means

Most of the times, researchers are faced with some situations where they have to compare the performances of a set of students in two different subjects or related subjects, reaction times, tolerance levels to two types of drugs or situations etc. When this happens, the pairs of samples are not independent. The samples can be constituted through randomization. Therefore, if the samples are matched, we assume that there is no difference between the two sets of scores or variables. It implies that $\overline{X}_1 = \overline{X}_2$. So $\overline{X}_1 - \overline{X}_2 = d$, and $\dfrac{\sum d}{n} = \overline{d} = 0$.

The t-statistic is therefore given by the formula:
$$ t = \frac{\overline{d}}{S/\sqrt{n-1}} $$

where $\overline{d} = \dfrac{\sum d}{n}$, S = standard deviation of the ds.

Example 20.3:

A set of students took tests in both Mathematics and Statistics. Their results are as follows:

S/N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Mathematics	50	65	70	35	44	52	67	72	48	38	59	65	62	40	54	64	70	55
Statistics	48	60	74	30	40	50	69	70	50	42	60	70	60	29	52	61	70	53

Are the results significantly different?

i.   Complete the table by getting d = difference (linear) between Mathematics and Statistics.

S/N	Mathematics	Statistics	D	d^2
1	50	48	2	4
2	65	60	5	25
3	70	74	–4	16
4	35	30	5	25
5	44	40	4	16
6	52	50	2	4
7	67	69	–2	4
8	72	70	2	4
9	48	50	–2	4
10	38	42	–4	16
11	59	60	–1	1
12	65	70	–5	25
13	62	60	2	4
14	40	29	11	121
15	54	52	2	4
16	64	61	3	9
17	70	70	0	0
18	55	53	2	4
$\sum$			**22**	**286**

ii.   Find $\bar{d}$ = mean of d = $\frac{\sum d}{n}$ = $\frac{22}{18}$ = **122**.

iii.   Find $\sum d^2$ = 286.

iv.   Find S = standard deviation.

$$S \quad = \quad \sqrt{\frac{n\sum d^2 - (\sum d)^2}{n}} \qquad = \quad \sqrt{\frac{18 \times 286 - 22^2}{18}}$$

$$= \quad \sqrt{\frac{5148 - 484}{18}} \qquad = \quad \sqrt{\frac{4664}{18}}$$

$$= \quad \textbf{16.097}$$

r substitute for the formula: $t \quad = \quad \frac{\bar{d}\sqrt{n-1}}{S}$

$$= \quad \frac{1.22 \sqrt{17}}{16.097} \quad = \quad \frac{5.038}{16.097} \quad = \quad \textbf{0.313}$$

Decision: t_{cal} = 0.313, t_{tab} at (17 : 05) = 2.131

Since t_{cal} is less than t_{tab} (critical value), we ACCEPT that there are no significant difference in the results, **OR** that the results are not significantly different.

3.5.4 Testing Hypothesis about Correlations

In the sections you have studied, you have seen how t-test can be used in different forms. You will have to note that when hypotheses testing involve the use of correlation coefficients, there are two ways to test them.

The first which you are familiar with is to use the table and find out if the correlation coefficient is significant.

The second is that, in stead of using the correlation coefficient directly from the table, you can subject it further to a t-test. In this case,

$$t = \sqrt{\frac{1-r^2}{n-2}} \qquad \text{or} \qquad t = \sqrt{\frac{n-2}{1-r^2}}$$

Example 20.4:

A teacher wanted to find out whet her students' scores in Technical Drawing have any significant relationship with their scores in Mathematics. He used the Pearson Product Moment Correlation Coefficient to do this. He came out with a correlation coefficient of $r = 0.60$, $N = 50$.

To find out if this is significant:

i.   Propose a null hypothesis: The students' scores in Technical Drawing and Mathematics are not significantly related, **OR,** There is no significant relationship between the students' scores in both Mathematics and Technical Drawing.

ii.   Substituting with the formula:

$$t = \sqrt{\frac{n-2}{1-r^2}} = 0.60\sqrt{\frac{50-2}{1-0.60^2}} = \frac{0.60\sqrt{48}}{\sqrt{0.64}}$$

$$= \frac{4.1569219}{0.8}$$

$$= \mathbf{\underline{5.196}}$$

iii.   Find the critical value by using $t_{(50-1\,:\,0.05)} = 2.021$.

iv.   Since t_{cal} is greater than t_{tab} i.e. $5.196 > 2.021$, we reject the null hypothesis and say the students' scores in Mathematics and Technical Drawing are significantly related.

Self Assessment Exercise 20.3:

In a research study, it was found that the correlation coefficient of two variables was 0.72 and the number of the respondents was 50. Propose a null hypothesis and test it using this information at 0.05 levels.

3.6   Analysis of Variance (ANOVA)

In the sections earlier, you studied the t-test and its uses in verifying hypotheses. In the test for hypothesis, we can also apply the analysis of variance (ANOVA) which is referred to as Fishers Test (F – test).

It is a more versatile test which can be used where two or more variables are involved for comparison. You can see that if more than two groups or variables are involved the z or t-tests cannot be used; ANOVA is used to determine the interaction effect of two or more variables, especially when the means of the sampled groups differ between and/or among the groups.

Example 20.5:

Scores of three randomly selected groups of students in an English test are given below.

GP 1	15	20	12	10	9	7	6	11	18	14	5
GP 2	13	12	15	19	20	11	8	14	10	9	4
GP 3	18	16	13	9	8	4	20	18	12	7	10

Test the hypothesis that the three groups do not belong to the same population.

S/N	X_1	X_2	X_3	X_1^2	X_2^2	X_3^2
1	15	13	18	225	169	324
2	20	12	16	400	144	256
3	12	15	13	144	225	169
4	10	19	9	100	361	81
5	9	20	8	81	400	64
6	7	11	4	49	121	16
7	6	8	20	36	64	400
8	11	14	18	121	196	324
9	18	10	12	324	100	144
10	14	9	7	196	81	49
11	5	4	10	25	16	100
$\sum$	**127**	**135**	**135**	**1701**	**1877**	**1927**
$\overline{X}$	**11.55**	**12.27**	**12.27**			

Find:

1. $\sum X_t$ = $\sum X_1 + \sum X_2 + \sum X_3$ = $127 + 135 + 135$ =   **<u>397</u>**

2. $\sum X^2_t \quad = \quad \sum X^2_1 + \sum X^2_2 + \sum X^2_3 = \quad 1701 + 1877 + 1927 = \quad \underline{\textbf{5505}}$

3. $N_t \quad = \quad N_1 + N_2 + N_3 \quad = \quad 11 + 11 + 11 \quad = \quad \underline{\textbf{33}}$

We shall take the correct factor to be $\dfrac{(\sum X_t)^2}{N_t} \quad = \quad \dfrac{(397)^2}{33}$

4. Sum of squares total (SS$_t$) $\quad = \quad \sum X_t^2 - \dfrac{(\sum X_t)^2}{N_t} \quad = \quad 5505 - \dfrac{157609}{33}$

$$= \quad 5505 - 4776.03 \quad = \quad \underline{\textbf{728.97}}$$

5. Sum of squares, between group (SS$_b$):

$$SS_b \quad = \quad \frac{(\sum X_t)^2}{N_1} + \frac{(\sum X_t)^2}{N_2} + \frac{(\sum X_t)^2}{N_3} - \frac{(\sum X_t)^2}{N_t}$$

$$= \quad \frac{127^2}{11} + \frac{135^2}{11} + \frac{135^2}{11} - \frac{397^2}{33}$$

$$= \quad 1466.2727 + 1656.8182 + 1656.8182 - 4776.03$$

$$= \quad 4779.9091 - 4776.03 \quad = \quad \underline{\textbf{3.891}}$$

6. Sum of squares, within group (SS$_w$): $\quad SS_w = SS_t - SS_b \quad = \quad 728.97 - 3.8791$

$$= \quad \underline{\textbf{725.09}}$$

7. Degree of freedom, Between (df$_b$) $\quad = \quad K - 1 = 3 - 1 = \underline{\textbf{2}}$.

8. Degree of freedom, Within (df$_w$) $\quad = \quad N - K = 33 - 3 = \underline{\textbf{30}}$. Where N = total number of samples.

9. Variance, between groups (V$_w$) $\quad = \quad \dfrac{SS_b}{df_b} \quad = \quad \dfrac{3.8791}{2}$

$$= \quad \underline{\textbf{1.94}}$$

10. Variance, within groups (V$_b$) $\quad = \quad \dfrac{SS_w}{df_w} \quad = \quad \dfrac{725.09}{30}$

$$= \quad \underline{\textbf{24.17}}$$

11. F – ratio $= \dfrac{V_b}{V_w} \quad = \quad \dfrac{1.94}{24.17} \quad = \quad \underline{\textbf{0.08}}$

12. Determine the critical value of F.

From the calculation $df_b = 2$ and $df_w = 30$, go to the F-table and find the point of intersection of 2 and 30 at 0.05 level. This will give you the F-value i.e. 3.32.

13. Decision: F – value calculated   =   0.08
               F – value critical   =   3.32

Since the calculated value is less than the critical value for the degrees of freedom 2 and 30, and alpha level of 0.05, we ACCEPT the null hypothesis that the scores are not significantly different.

For the purpose of presenting the result in a research report, a summary of the results is shown in a table while the computations are shown in the appendix. Thus:

Sources of Variation	Sum of squares	Degree of freedom	Variance	Fcal	F-crit	Decision
Between groups	3.8791	2	1.94			
Within groups	725.0900	30	24.17	0.08	3.32	Accept H_0
Total	**728.9691**	**32**				

Self Assessment Exercise 20.4:

S/N	1	2	3	4	5	6	7	8	9	10
X_1	6	7	13	8	12	5	10	6	9	11
X_2	15	14	10	12	13	11	14	10	12	13
X_3	5	8	10	15	4	13	7	13	6	9
X_4	10	7	5	8	9	8	6	4	7	3

Use the data above to verify a null hypothesis at 0.05.

Now that you have seen ANOVA and how to use it, we can now go to the next test. But before we do that, you have to note that ANOVA can be one-way as in the example given, two-way or multiple ANOVA. We are not going to discuss these other ones here. However, you will meet them including ANCOVA – analysis of covariance in your master's degree programme. For now, let us turn to the chi-square.

3.7   The Chi-Square

The word chi is pronounced kai. The chi-square is a test of independence which is used for analyzing data that are in the form of frequencies occurring in two or more mutually exclusive or discrete variables being compared. The test allows us to determine whether or not a significant difference exists between the observed frequencies of cases in each category of variables studied versus the expected frequencies or data or number of cases in each category of variables based on the null hypothesis. The observed frequency is data obtained from the actual frequency count while the expected is the data that would be obtained if equal numbers responded to the same variables equally. The larger the margin between the observed and the expected frequency

counts, the higher the chi-square value. You can compare the calculated chi-square against a given critical value to determine whether it is significant. The formula for chi-square is:

$$\chi^2 = \sum \frac{(f_o - f_e)^2}{f_e}$$ where f_o is the observed frequency, and f_e is the expected frequency in each cell.

Example 20.6:

A survey to determine the preference pattern of some parents on the choice of courses for their children is given in a table below. Use a null hypothesis to determine whether the indicated preference pattern is statistically significant.

Frequency	Business	Law	Medicine	Engineering	Total
Observed	24	50	52	34	160
Expected	40	40	40	40	160

Steps:

i.   State the null hypothesis H_0: There is no significant difference between the expected and observed preference pattern of the parents at 0.05 alpha levels.

ii.   Apply the chi-square formula in each cell and sum up at the end.

1. For Business $\quad = \quad \dfrac{(O - E)^2}{E} \quad = \quad \dfrac{(24 - 40)^2}{40} \quad = \quad 6.4$

2. For Law $\quad = \quad \dfrac{(O - E)^2}{E} \quad = \quad \dfrac{(50 - 40)^2}{40} \quad = \quad 2.5$

3. For Medicine $\quad = \quad \dfrac{(O - E)^2}{E} \quad = \quad \dfrac{(52 - 40)^2}{40} \quad = \quad 3.6$

4. For Engineering $\quad = \quad \dfrac{(O - E)^2}{E} \quad = \quad \dfrac{(34 - 40)^2}{40} \quad = \quad 0.9$

$\therefore \qquad \chi^2 \quad = \quad \sum \dfrac{(O - E)^2}{E} \quad = \quad 6.4 + 2.5 + 3.6 + 0.9 = \underline{\textbf{13.4}}.$

To take decision on the significance of the χ^2 value, you have to find the degree of freedom df. The example discussed above is a one-variable case, so the df is given by: df = K – 1, i.e. (4 – 1) = 3. As usual, go to the chi-square table and look under df = 3, and your alpha level, which can be 0.05 or 0.01. Again, if the calculated value exceeds the value on the table, you reject the null hypothesis. In this case χ^2 at 3 : 0.05 = 7.82. This is less than the calculated value, so we reject the null hypothesis.

Most of the times, researchers are confronted with the test for the independence of two variables. For instance, gender and opinion, or religion and choice or age and opinion. Again, each of the

variables may have two or more levels. The observed and the expected frequencies are presented in a table called contingency table. It has a number of rows and columns.

Example 20.7:

The enrolment pattern of students to different academic programmes according to religion is given in the table below. Calculate the chi-square and test for the significance at 0.05.

Religion	Academic Programmes				
	Business	Law	Medicine	Engineering	Totals
Christianity	50	35	48	45	178
Islam	30	45	35	50	160
Traditional	45	30	25	40	140
Godian	25	20	30	28	103
Totals	150	130	138	163	581

To solve this problem, take the table above as the table of the observed frequencies. Therefore, you will need the table for the expected frequencies. To find the expected frequency for each cell, apply the formula:

$$\frac{\text{column total x row total}}{\text{overall total}}$$

Example, for cell 1, where the observed is 50, the expected is given by $\frac{150 \times 178}{581} = $ **45.96**.

For the next cell where the observed as 35, the expected is given by $\frac{130 \times 178}{581} = $ **39.83** etc.

The expected frequencies are better presented in a table like the observed. See the table below.

Religion	Academic Programmes				
	Business	Law	Medicine	Engineering	Totals
Christianity	45.96	39.83	42.28	49.94	178
Islam	41.31	35.80	38.00	44.89	160
Traditional	36.14	31.33	33.25	39.28	140
Godian	26.59	23.05	24.46	28.90	103
Totals	150.0	130.01	138.00	163.01	581

To get the chi-square value, we use $\sum \frac{(O - E)^2}{E}$

Instead of taking the cells one by one, we use a table to do the same thing in a short time. Let us use a table to calculate the chi-square.

O	E	O – E	$(O – E)^2$	$(O – E)^2/E$
50	45.96	4.04	16.32	0.36
30	41.31	–11.31	127.92	3.10
45	36.14	8.86	78.50	2.17
25	26.59	–1.59	2.53	0.10
35	39.83	–4.83	23.33	0.59
45	35.80	9.20	84.64	2.36
30	31.33	–1.33	1.77	0.06
20	23.05	–3.05	9.30	0.40
48	42.28	5.72	32.72	0.77
35	38.00	–3.00	9.00	0.24
25	33.25	–8.25	68.06	2.05
30	24.46	5.54	30.69	1.25
45	49.94	–4.94	24.40	0.49
50	44.89	5.11	26.11	0.58
40	39.28	0.72	0.52	0.01
28	28.90	–0.90	0.81	0.03
				14.56

From the calculation shown above, the calculated value is:

$$\chi = 14.56, df = (c – 1)(r – 1) = (4 – 1)(4 – 1) = 9.$$

For decision, go to the table to look for the critical value at df = 9, alpha = p = 0.05. χ^2_{tab} = 16.92.

Since the calculated value of 14.56 is less than the critical value of 16.92, we Accept the null hypothesis that there is no significant difference between the observed values and the expected values.

Self Assessment Exercise 20.5:

Use the data below to verify your proposed null hypothesis:

Gender	VX	VY	VZ	Total
Male	55	40	50	145
Female	35	25	40	100
Total	90	65	90	245

4.0   CONCLUSION

Now that you have successfully worked through this unit on how to test hypotheses, you are now prepared to carryout your research project work. But before you go properly into that, we shall introduce you to how to write research reports in the next unit.

5.0 SUMMARY

In this unit, we have discussed the selection of the alpha level or significance level and we said the two most common alpha levels used in research are 0.05 and 0.01. We touched upon the degrees of freedom, Type I error and Type II error as the likely errors that can be made in decision making in the test of hypothesis.

Hypotheses can be frame in two formats, which are directional and non-directional. This implies that we have two types, vis-à-vis one tailed test and two tailed test. You also studied the different types of tests used in testing hypotheses. The t-test, the F-test and the chi-square are the prominent.

In the next unit, you will be introduced to how to write your research reports.

6.0 TUTOR MARKED ASSIGNMENT

A class of students did a test in Introduction Technology when they were in JS.2. The same class of students studied Technical Drawing in their SS.2. The results are given in the table below. What is the correlation coefficient of these sets of scores? Propose a null hypothesis and verify it using t-test on the result of the correlation coefficient.

S/N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Introduction Technology	20	18	17	25	22	15	13	10	19	24	16	8	5	14	12
Technical Drawing	25	20	18	24	20	17	18	15	19	20	20	12	10	22	14

Answer to SAE Question 20.1

$P < 05$: This is a 5% alpha level or level of significance which means that if a study is replicated 100 times, the same outcome will occur 95 out of 100, while 5 out of 100 may vary due to chance.

Degree of freedom: This is the number of observations which are free to vary when certain restrictions have been placed on the data being considered.

Type I and Type II errors: The rejection of a true null hypothesis when it should have been accepted is called Type I error, while the acceptance of a false null hypothesis when it should have been rejected is called Type II error.

Two tailed and on tailed test: When a hypothesis is stated in such a way that it does not indicate a direction of difference but agrees that there is a difference, two tailed test is applied. For example, most of the null hypotheses are two-tailed. When a hypothesis is stated to indicate the direction of difference, it is called a one-tailed test.

Answer to SAE Question 20.2

i. H_0 = The gender-wise performances are not significantly different.

ii. t = $\dfrac{\overline{X} - \overline{X}}{\sqrt{\dfrac{[(n_1-1)\,S_1^2 + (n_2-1)\,S_2^2)]\,((n_1+n_2)}{(n_1 + n_2 - 2)\,n_1 \times n_2}}}$

t = $\dfrac{65 - 58}{\sqrt{\dfrac{[(45-1)\,11.5^2 + (40-1)\,14.2^2)]\,(45+40)}{(45 + 40 - 2)\,45 \times 40}}}$

= $\dfrac{7}{\sqrt{\dfrac{[(44 \times 132.25) + (39 \times 201.64)]\,85}{83 \times 1800}}}$

= $\dfrac{7}{\sqrt{\dfrac{(5819 + 7863.96)\,85}{149400}}}$

= $\dfrac{7}{\sqrt{\dfrac{1163051}{149400}}}$

= $\dfrac{7}{\sqrt{7.7848166}}$ = $\dfrac{7}{2.7901284}$

= 2.5088451   = **2.509**

iii. Decision:

t_{cal} = 2.509, t_{tab} at (45+40 – 2 : 0.05/2) = t_{tab} at 83 : 0.05; t_{cal} = 3.73. $t_{(153\,:\,0.025)}$ = 1.98

Since t_{cal} is greater than t_{tab}, we reject H_0, and accept that the performances are significantly different.

Answer to SAE Question 20.3

(i)   Propose a null hypothesis: The two variables are not significantly related **OR** There is no significant relationship between the two variables.

(ii)   Substituting with the formula:

$$t \quad = \quad \sqrt{\frac{n-2}{1-r^2}} \quad = \quad 0.72\sqrt{\frac{50-2}{1-0.72^2}} \quad = \quad \frac{0.72\sqrt{48}}{\sqrt{0.8416}}$$

$$= \quad \frac{0.72 \times 6.928203}{0.9174} \quad = \quad \frac{4.9883}{0.9} \quad = \quad 5.5425$$

$$= \quad \underline{\mathbf{5.543}}$$

(iii)   Find the critical value by using $t_{(50-1:0.05)} = 2.021$.

(iv)   Since t_{cal} is greater than t_{tab} i.e. $5.543 > 2.021$, we reject the null hypothesis and say the two variables are significantly related.

Answer to SAE Question 20.4

S/N	X_1	X_2	X_3	X_1^2	X_2^2	X_3^2	X_4^2
1	6	15	5	36	225	25	100
2	7	14	8	49	196	64	49
3	13	10	10	169	100	100	25
4	8	12	15	64	144	225	64
5	12	13	4	144	169	16	81
6	5	11	13	25	121	169	64
7	10	14	7	100	196	49	36
8	6	10	13	36	100	169	16
9	9	12	6	81	144	36	49
10	11	13	9	121	169	81	9
$\sum$	**87**	**124**	**90**	**825**	**1564**	**934**	**493**
X	**12.4**	**9.0**	**7.7**				

1. $\sum X_t \quad = \quad \sum X_1 + \sum X_2 + \sum X_3 + \sum X_4 \quad = \quad 87 + 124 + 90 + 67 \quad = \quad \underline{\mathbf{368}}$

2. $\sum X_t^2 \quad = \quad \sum X_1^2 + \sum X_2^2 + \sum X_3^2 + \sum X_4 = \quad 825 + 1564 + 934 + 493 = \quad \underline{\mathbf{3816}}$

3. $N_t \quad = \quad N_1 + N_2 + N_3 + N_4 \quad = \quad 10 + 10 + 10 + 10 \quad = \quad 40$

We shall take the correct factor to be $\dfrac{(\sum X_t)^2}{N_t} \quad = \quad \dfrac{(368)^2}{40}$

4. Sum of squares total (SS_t) = $\sum X_t^2 - \dfrac{(\sum X_t)^2}{N_t}$ = $3816 - \dfrac{135424}{40}$

                          = $3816 - 3385.6$ = **430.4**

5. Sum of squares, between group (SS_b):

$$SS_b = \frac{(\sum X_1)^2}{N_1} + \frac{(\sum X_2)^2}{N_2} + \frac{(\sum X_3)^2}{N_3} + \frac{(\sum X_4)^2}{N_4} - \frac{(\sum X_t)^2}{N_t}$$

$$= \frac{87^2}{10} + \frac{124^2}{10} + \frac{90^2}{10} + \frac{67^2}{10} - \frac{368^2}{40}$$

$$= 756.9 + 1537.6 + 810.0 + 448.9 - 3385.6$$

$$= 3553.4 - 3385.6 \quad = \quad \textbf{167.8}$$

6. Sum of squares, within group (SS_w): $SS_w = SS_t - SS_b$ = $430.4 - 167.8$

                                             = **262.6**

7. Degree of freedom, Between (df_b) = $K - 1 = 4 - 1 = \underline{\textbf{3}}$.

8. Degree of freedom, Within (df_w) = $N - K = 40 - 4 = \underline{\textbf{36}}$. Where N = total number of samples.

9. Variance, between groups (V_w) = $\dfrac{SS_b}{df_b}$ = $\dfrac{167.8}{3}$

                                             = **55.93**

10. Variance, within groups (V_b) = $\dfrac{SS_w}{df_w}$ = $\dfrac{262/6}{36}$

                                             = **7.29**

11. F – ratio = $\dfrac{V_b}{V_w}$ = $\dfrac{55.93}{7.29}$ = **7.672**

12. Critical value of F.

From the calculation $df_b = 3$ and $df_w = 36$, go to the F-table and find the point of intersection of 3 and 36 at 0.05 level. This will give you the F-value i.e. 2.29.

13. Decision: F – value calculated = 7.672

                      F – value critical = 2.29

Since the calculated value is greater than the critical value for the degrees of freedom 3 and 36, and alpha level of 0.05, we REJECT the null hypothesis that the scores are not significantly different.

For the purpose of presenting the result in a research report, a summary of the results is shown in a table while the computations are shown in the appendix. Thus:

Sources of Variation	Sum of squares	Degree of freedom	Variance	Fcal	F-crit	Decision
Between groups	167.8	3	55.93			
Within groups	262.6	36	7.29	7.67	2.29	Reject H_0
Total	**430.4**	**39**				

Answer to SAE Question 20.5

Observed

Gender	VX	VY	VZ	Total
Male	55	40	50	145
Female	35	25	40	100
Total	**90**	**65**	**90**	**245**

Expected

Gender	VX	VY	VZ	Total
Male	53.3	38.5	53.3	145
Female	36.7	26.5	36.7	100
Total	**90.0**	**65.0**	**90.0**	**245**

O	E	O – E	$(O - E)^2$	$(O - E)^2/E$
55	53.3	1.7	2.89	0.05
35	36.7	–1.7	2.89	0.08
40	38.5	1.5	2.25	0.06
25	26.5	–1.5	2.25	0.08
50	53.3	–3.3	10.89	0.20
40	36.7	3.3	10.89	0.30
				0.77

$$\chi = 14.56, df = (c – 1) (r – 1) = (3 – 1) (2 – 1) = 2.$$

χ^2_{tab} at 2 : 0.05 = 5.99; alpha = p = 0.05. χ^2_{tab} = 0/77.

Since the calculated value of 0.77 is less than the critical value of 5.99, we Accept the null hypothesis that there is no significant difference between the observed values and the expected values.

7.0 REFERENCES AND FURTHER READINGS

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UNIT 21   WRITING RESEARCH REPORTS

Table of Contents

1.0   INTRODUCTION

The final stage of any research process is the writing of the research report. Research is very important, because the findings generated can be used for rational decision-making and, according to Nkpa (1979), as a springboard for further research.

The main aim of writing research report is to communicate or disseminate the research findings to the literate audience. In writing the research report, the impersonal mode is preferred. That is to say, instead of say "I did this", you should say "the study was carried out to do this".

You will have to note that in presenting a research report, you have to use the required format. Most institutions have their own format. These formats or house-styles do not vary significantly from the general format.

National Open University of Nigeria (NOUN), School of Education, has its own house-style. You supervisor will let you have it. For the purpose of this unit, we shall discuss the general format.

2.0   OBJECTIVES

At the end of this unit, you should be able to:

(i)   Itemise the chapter titles and sub-titles in a research project report;
(ii)   Prepare a research report based on the given format.

3.0   MAIN CONTENT

3.1   Sample Format of a Research Report

As you have seen in the introduction, a research project report is a detailed account of what the researcher has done in the process of carrying out the research the findings of this study. The report is not presented in any form. It follows an agreed format as summarised below. This format is only a guideline. Though this is the conventional format, only relevant section should be used in line with your house-style.

1. Preliminary pages:

i.	Title page
ii.	Approval / Acceptance page
iii.	Certification page
iv.	Dedication
v.	Acknowledgement page
vi.	Abstract
vii.	Table of Contents
viii.	List of tables
ix.	List of figures
x.	List of appendices

2. Chapter 1: Introduction

i.	Background to the Problem
ii.	Statement of the Problem
iii.	Purpose / Objectives of the Study
iv.	Significance of the Problem
v.	Scope of the Study
vi.	Research Questions and/or Hypotheses
vii.	Definitions of Terms

3. Chapter 2: Literature Review

i.	Review of Related Literature
ii.	Conceptual Framework

4. Chapter 3: Research Methodology

i.	Research design
ii.	Population
iii.	Samples and Sampling techniques
iv.	Instrumentation – construction of instruments, validation, reliability of instruments, administration and scoring
v.	Methods of data analysis

5. Chapter 4: Presentation of Results

    i.   Data analysis and findings
    ii.   Summary of major findings

6. Chapter 5: Discussion

    i.   Interpretation of findings
    ii.   Discussion of findings
    iii.   Implication of the study
    iv.   Recommendations
    v.   Limitations
    vi.   Suggestions for further study

7. Supplementary page:

    i.   Bibliography
    ii.   Appendices
    iii.   Index

3.2   Steps in Research Report Format

You have already noted that a research report is a straight forward, clearly and precisely written document in which you attempt to explain how you have resolved the problem before you. The presentation, in this unit, is consistent with the most acceptable formats. So let us explain them.

3.2.1 Preliminary Pages

i.   ***The title page***: This is the first page of this section. It contains the title of the study, the name of the author, the relationship of the research to a course or degree requirement, name of the institution where the report is to be submitted, and the date of presentation.

        The title should be concise and state clearly the purpose of the study. The essential elements to be included in the title are the major variables and the target population. These should be phrased in such a way as to describe what the study is all about. You should not state your title so broadly that it may claim more than it can actually deliver. For instance, sex differences in the enrolment of SSCE candidates in Technical Drawing from 2004 to 2007, or The effect of group discussions on learning outcomes in the Open and Distance Education system. You can note the variables here. The title should be typed in capital letters, single-spaced, and centred between the right and left margins of the page.

ii.   ***Approval / Acceptance page***: The specifications vary from institution to institution. It contains some of the following information: the names, signatures of the head of department, the dean, the supervisor(s) and dates, the names(s) of the student(s).

iii. **Certification page**: This contains the attestation of originality of the research project. It may also include the name and signature of the external examiner.

iv. **Dedication**: Here, emotionally-laden words may be permitted in order to pay tribute to persons who are dear to the author or those who contributed in one way or the other to the success of the project and those who would particularly be interested in the research findings.

v. **Acknowledgement page**: This is used to express gratitude to those who helped in the process of conducting the research and preparing the report. It should be simple and restraining.

vi. **Abstract**: This is a succinctly summarised form of the report containing the aim of the investigation, the sample, methods of investigation, the instruments used for data collection, the analysis and findings.

vii. **Table of Contents**: This serves an important purpose of providing the outline of the contents of the report. It lays out in a tabular form, the chapters, headings and sub-headings of the report. It is sequentially arranged and numbered from the preliminary to the supplementary pages. Page references for each topic are so indicated.

viii. **List of tables and figure and appendices**: If tables and/or figures are used in the report, a separate page is included for each list. It should indicate the page numbers in which the tables or figures presented in the report are located. The numbers and titles are serially listed. Also contained is the list of appendices that are embodied in or annexed to the report.

The pages of the preliminary section are numbered with lower-case Roman numerals (i, ii, iii, iv, v, etc).

3.2.2 Introduction

i. **Background to the Problem**: Here, such factors or circumstances that informed the investigation are traced. It is presented using reasoned statements to show that it is worthwhile to dissipate resources to carryout the study. It shows the nature, scope, and current status of the factors affecting the problem.

It has to be presented in a way as to be clear and convincing to the reader.

ii. **Statement of the Problem**: The problem as already highlighted is stated in simple, clear and unambiguous terms. This is not required to be too long.

iii. **Purpose of the Study / Objectives of the Study**: These go interchangeably, but it states the specific aspects of the study and the reasons for focusing on them. It includes statements of what should be accomplished and all that would be investigated.

iv.   ***Significance of the Problem***: The usefulness, the utility value of the research or findings of the research should be articulated. The institutions, groups or individuals who are expected to profit or benefit and the benefits expected to accrue to them are to be stated in this section.

v.   ***Scope of the Study***: This is interchanged with the delimitation of the study. Here, you will have to indicate the extent to which the study will be covered. It involves the geographical area, time period, and variables to be covered.

vi.   ***Research Questions and/or Hypotheses***: These are formulated based on the type of research and the variables under investigation. They should be formulated to provide answers to the problems under study.

vii.   ***Definitions of Terms***: The essence of definition is to ensure that the reader understands the specific meanings ascribed to the terms by the author. So you have to use this to educate the readers on the operational meaning of any coined, technical words, phrases or expressions which cannot otherwise be understood because of their unconventional usage.

3.2.3   Literature Review

i.   ***Review of Related Literature***: This is the second chapter of your project report. It is meant to give the reader an understanding of some of the works or study already carried out in the area of the project. It will also give the reader an overall picture of the problem you are solving. You are therefore required to review only the important literature related to your study, abstract previous research studies and review significant writings of authorities in the area under study.

By so doing, a background for the development of your study will be provided. It will also bring the reader up-to-date. Apart from providing evidence of the investigator's knowledge of the field of study, it highlights the areas of agreement or disagreement in findings or gaps in existing knowledge.

Do not use the article-by-article presentation in your literature review. In other words, do not collect abstracts of previous researches and string them together without any attempt at continuity or logical organisation. Again do not make excessive use of quotations. Quotations are used only when the material quoted is especially well written and can be inserted without spoiling the continuity of the presentation (Olaitan and Nwoke, 1988).

ii.   ***Conceptual Framework***: This states the concept that informed the study. These concepts such as system concept, management by objectives concept, etc. will assist you to bring out salient points that would assist to important literature related to your study, abstract of previous research studies and review significant writings of authorities in the area under study.

3.2.4 Research Methodology

i. ***Research design***: This lays out the master-plan for the research project. It shows the extent to which extraneous variables were controlled or eliminated. You should therefore describe any plan used clearly, even if it cannot be classified under a conventional label. All lapses should be reported as a limitation.

ii. ***The Population***: You should specify all the necessary parameters to ensure that the constituents and characteristics of the target population are unambiguous. The target population may be people, animals, objects or events.

iii. ***Samples and Sampling techniques***: The size of the sample and how the sample was selected should be so described in such a way as not to leave the reader in doubt about what you have done. Do not just say 100 respondents were randomly selected from the population. Specify the method in which the simple random sampling was used. Is it by the use of table of random numbers, describe whether pieces of numbered papers were jumbled in a box and picked up at random, etc.

iv. ***Instrumentation***: In this section, you have to describe in full details the tools for data collection. Such tools like questionnaire, attitude scales, tests, etc. should be fully described to show their characteristics. You will have to report the reliability indices and validation procedures. Where you used a standard instrument, in your report, you have to give the rationale for the appropriateness. Where a new instrument is developed, you have to outline the necessary procedures followed in both the construction and validation.

v. ***Data Collection***: What methods did you use in your data collection? Did you use research assistants? If yes, did they undergo training? Did you collect the data personally, or by post? What problems did you encounter in the process of data collection? All the steps which you have taken to ensure the collection of valid that should be reported.

vi. ***Methods of data analysis***: In this section, you will describe the techniques which you applied in the data analysis and the reasons for the choice. The reasons may be in relation to the type of design, nature of the samples on the type of data. Try to use the simplest, well known method of data analysis. But where you use a mode of analysis not widely known details of such method should be reported.

3.2.5 Results and Discussion

i. ***Presentation and Analysis of data***: This is the heart of the research report. The results are clearly and concisely set out using the most illuminative modes of presentation. Tables, figures, graphs and textual descriptions are used to clarify significant relationships. They should be serially numbered and titled so as to be self explanatory. They should be simple and should be directly related to the hypotheses and/or the research questions.

ii.   ***Interpretation of the finding***: The most important task which you have to undertake in writing the results of your study is to identify and interpret the major findings. You should be able to discuss possible reasons why the results occurred the way they did. You should try to fit them into the findings of previous research, suggest the applications to the field and make theoretical interpretations.

3.2.6   Summary and Conclusions

i.   ***The Summary***: In this section, you should clearly and concisely restate the problem, the hypotheses and/or research questions, the main features of the method omitting most of the details concerning the subjects and measures and list the main findings.

The summary must be very brief, but consistent with a clear presentation of all important information about the problem, method and findings. The findings should be listed by number. You should summarise each major finding in one or two statements.

ii.   ***The Conclusion***: This gives answers to the questions raised or the statements of acceptance or rejection of the hypotheses. It should be based solely on the findings generated by the research.

iii.   ***Implication of the study***: In this section, you may include ideas on the relevance of the findings to educational theory and practice. But these ideas should be directly be derived from the study.

iv.   ***Suggestions for further study***: It may be appropriate here to suggest areas of problems for further investigation. This is made as a result of matters arising from the research.

3.2.7   Supplementary Pages

i.   ***Bibliography***: In this section, you should include all references cited in the report and those not cited, but consulted to shed light on the problem. References are cited uniformly and according to a given style.

Most universities adopt the APA format. References are done serially and alphabetically. You can look for the APA format and go through it.

ii.   ***The Appendices***: This contains extra information which is part of the report the reader should know about, but not necessarily for inclusion in the main report. They include long tables, forms, instruction aids, data collecting instruments, items analysis data, scoring protocols and procedures, lengthy quotations etc.

Each separate entry heading is listed as APPENDIX A, APPENDIX B, etc.

Self Assessment Exercise 21.1:

Go to any university library and select three different research projects. List the items on the table of content and compare them.

4.0 CONCLUSION

At the end of your programme, you are expected to carryout a research. At the end of the research, you are also expected to submit a written report of the investigation. In this unit, you have gone through the involvement in the writing of the report. A very important demand here is that you must be as objective as possible in your report. At the initial stage, you cannot make any statement that would show you are in favour or against an idea. Your report should be devoid of emotional or subjective statements. You should arrange the different parts of the report so as to make it possible for a reader to easily locate any section of particular interest to him.

5.0 SUMMARY

In this unit, we have discussed and presented a sample format of a research report. We have also discussed these steps in details stating from the preliminary stages to the supplementary stages. We have emphasised that your reports should not be presented with personal pronouns like I, my, we etc. Instead use impersonal pronouns and passive voice. You should make sure that the report is written in a clear, simple and straightforward style. Your motive should be effective communication. Therefore, use very simple language. You should always be brief so as not to bore your reader. Abbreviations should only be used after they have been written in full earlier. Avoid the use of generalizations or conclusions, which are not supported by the findings. We also said that every source cited in the work or used but noted cited in the work should be documented in the reference page. Improper citation or inability to give details of a source cited in the body of the work should be documented in the reference page. Improper citation or inability to give details of a source cited in the body of the work should be avoided. Remember that proofread the report thoroughly after typesetting. This will help you not submit avoidable errors.

Congratulations for being part of the success story of NOUN, and for graduating in this programme.

6.0 TUTOR MARKED ASSIGNMENT

Pick up any four (4) research projects. Study the abstracts. What are the things that are common to all of them?

Answer to Question 21.1

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    ii.   Discussion of findings
    iii.   Implication of the study
    iv.   Recommendations
    v.   Limitations

7. Supplementary page:

7.0   REFERENCES AND FURTHER READINGS

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