METHODOLOGY OF BASIC AND APPLIED RESEARCH

2[nd] Edition

Edited by:
A. I. Olayinka, V. O. Taiwo, A. Raji - Oyelade and I. P. Farai

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Foreword

The Vision of the University of Ibadan for the 21st century places great premium on research activities, with emphasis on, first, those things that are of purely academic interest (i.e. basic or pure research) and, second, those areas which are aimed at problem solving (i.e. applied research). Consequently, it gives me great pleasure to write the foreword to this book on Methodology of Basic and Applied Research.

There is no doubt that most postgraduate students have difficulties in conceptualizing a research framework, as well as in conducting, managing and reporting research. Moreover, the business of applying for competitive research grants requires special skills in the art and science of writing. The problems faced by beginner researchers can be very daunting. Unfortunately, there are not too many resource materials around that treat these topics exhaustively. I have no doubt whatsoever that the primary motivation for writing this book must have been the desire to fill this yawning gap. This is why I would like to congratulate the leadership of the Postgraduate School for the initiative.

I am especially heartened that all the chapters of the book are written by members of the academic staff at the University of Ibadan. It is gratifying to note that the contributors have been drawn from as many as 12 faculties and 2 research centres. I am particularly delighted with the array of eminent and distinguished scholars from the respective disciplines that agreed to be part of this book writing project. The book is, therefore, necessarily inter- and multi-disciplinary in outlook. Moreover, it is significant to note that the contributors have come up with a unique University of Ibadan Manual of Style. You should make all efforts to popularize this style sheet which has incorporated attributes from the previously existing acceptable styles of referencing.

Whether you are a research student or a postgraduate teacher, in this University in particular and similar institutions in other parts of the world in general, I hope you will use this authoritative work to advance learning and knowledge.

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Preface

Although many departments in the University of Ibadan teach courses on Research Methodology at the postgraduate levels, it has been observed that newly registered doctoral candidates do not often have a clear insight about what a PhD research entails. This could lead to frustration along the way, with many candidates spending more years than necessary on the research, or even dropping out of the programme completely. Similarly, many young academics, even on the successful completion of their doctoral programmes still find it difficult to write academic papers and make progress on the career ladder.

On account of the foregoing, the Postgraduate School decided during the first quarter of 2004 to organize a workshop on Methodology of Basic and Applied Research, with emphasis on inter-disciplinary approaches. Senior members of the academic staff were then invited specially to serve as contributors on the respective themes. The members were chosen based on proven previous contributions to the development of postgraduate education, training and research. It is gratifying to note that we succeeded in attracting eminent academics and researchers from 12 different Faculties and one Research Centre. What has emanated from the collective effort is no doubt inter- and multi-disciplinary in outlook.

The materials presented in this book will be used at workshops on Research Methodologies which we hope will be mounted at the beginning of each session for new postgraduate intakes. We reckon that an intensive five-day workshop will suffice to cover the materials. On completion of the workshop, there should be a substantial reduction in the average length of time it takes to complete a PhD at the University of Ibadan. Second, there should be an improvement in the quality of theses accepted for higher degrees of the University. Third, the junior academics participating would encounter less difficulty in academic writing, with the attendant improvement in their career growth.

The topics covered are fairly comprehensive, and include: Definition, spectrum and types of research; Design and development of conceptual framework in research; Systematic collection of data (laboratory, field, clinical, etc); Analysis of qualitative data; Use of statistics in analysing quantitative data and making inferences; Use of computers; Data retrieval; Developments in information and communication technologies (ICT) for research purposes; Preparing a research proposal (for a doctoral thesis and for grants); Writing theses and academic papers; Acceptable styles of referencing; Ethics in research; Challenges in conducting research in developing countries; and Common Errors in Research.

The first edition of Methodology of Basic and Applied Research, which was published in 2005, was well received. Based on the peer-review comments this second edition has incorporated two new chapters on: "The link between everyday reasoning, scientific reasoning, scientific research and theory" and "Use of the Research Questionnaires", respectively. These new additions will surely enrich the contents of the book.

This book is targeted primarily at research students and young academics. More experienced researchers should also find aspects of the book very useful and informative.

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DEFINITION, SPECTRUM AND TYPES OF RESEARCH

Fawole, I., Egbokhare, F.O., Itiola, O.A., Odejide, A. I. and Olayinka, A.I.

INTRODUCTION

Research is a process built around three key features:

- clearly articulated research questions to be addressed through the research, and a related series of objectives which will enable the questions to be explored and answered.
- the specification of a research context for the questions, and a rationale stating why it is important that these particular questions should be answered or explored. This description of context should make clear what other research is being or has been conducted in this area, and what particular contribution this particular project will make to the advancement of creativity, insights, knowledge and understanding in this area.
- the specification of appropriate research methods for addressing and answering the research questions, and a rationale for the use of particular methods.

SOME DEFINITIONS OF RESEARCH

There can be many definitions of research. A partial list is provided below:

- accessible – a public activity, open to scrutiny by peers,
- transparent – clear in structure, process and outcomes,
- transferable – useful beyond the specific research project, applicable in principles (if not specifics) to other researchers and research contexts.

- Research is an endeavour to study or obtain knowledge through the use of a systematic approach with the intent of clarification.
- Research is a curiosity-driven activity that has the purpose of discovery and advancement of knowledge (Basic research).
- Research is a systematic investigation including research development, testing and evaluation, designed to develop or to contribute to generalizable knowledge.
- Research is a systematic investigation designed to develop or contribute to general knowledge.
- Research is a systematic study directed towards more complete scientific knowledge or understanding of the subject studied.
- Research is a form of inquiry that involves seeking of evidence to increase knowledge. It involves a systematic process for recognizing a need for information, acquiring and validating that information and deriving conclusions from it.
- Research is investigation and experimentation aimed at discovery, interpretations and application of scientific data.
- Research with experimental development is a creative work undertaken on a systematic basis in order to increase knowledge, including knowledge of humanity, culture and society and the use of this stock of knowledge to device new applications (OECD).

Running through the above-listed definitions, we note the following characteristics:

- research is systematic,
- research is designed to obtain knowledge, and
- the results of a research are verifiable.

(For further definitions of research, see Appendix 1.)

All researches have ontological and epistemological positions whether acknowledged or not. In other words, research has a range of underpinnings, as well as methodological techniques/practices. It has to be theoretically engaged, hence

- research is undergirded by theory,
- research is not value free,
- research is about rigour.

SPECTRUM OF RESEARCH

The spectrum of research ranges from basic research right through applied research and to experimental development.

Pure Basic Research

This encompasses experimental or theoretical work undertaken primarily to acquire new knowledge without a specific application in view. It also refers to a body of work carried out without looking for long-term economic or social benefits other than advancement of knowledge.

Strategic Basic Research

This involves experimental or theoretical work undertaken primarily to acquire new knowledge without a specific application in view, and is directed into specific broad areas in the expectation of useful discoveries. It provides the broad base of knowledge necessary for the solution of recognized practical problems.

Applied Research

This refers to an original work undertaken to acquire new knowledge with a specific practical application in view. Applied research is undertaken to determine possible uses for the findings of basic research or to determine new methods or ways of achieving some specific and pre-determined objectives.

Experimental Development

This is work undertaken for the purpose of achieving technological advancement for the purpose of creating new, or improving existing materials, devices, products or processes, including incremental improvements thereto.

In experimental development, the objective is the achievement of technological advancement, whereas in basic and applied research the objective is the advancement of scientific knowledge. In either case, there is no requirement that the attempt be successful. The following describe experimental development:

- Experimental development is the attempt to achieve technological advancement for the purpose of creating new, or improving existing materials, devices, products or processes, including incremental improvements.
- Experimental development follows a systematic investigation or search by experiment or analysis in a field of technology.
- Experimental development is typically carried out in a commercial setting.
- The technological advancement can be either embodied in the new or improved materials, devices, products or processes, or represented by the technological know-how gained.
- An attempt to resolve technological uncertainty is an attempt to achieve technological advancement.
- The technological advancement sought must be identified within the business context of the taxpayer.
- Work with respect to engineering, design, operations research, mathematical analysis, computer programming, data collection, testing and psychological research is included as experimental development if it is "directly in support" of and "commensurate with the needs" of the experimental development being undertaken.

Work that directly contributes to the attempt to achieve a technological advancement is experimental development regardless of what the work is called.

MODES OF CONDUCTING RESEARCH

Research may be conducted as collaborative research, contract research, sponsored research or consultancy.

Collaborative research

These are research projects jointly developed by two or more individuals, institutions or organizations.

Contract research

This involves request made by industry or governmental agency for a specified research project to be carried out, with identified aims and objectives. The research project is often undertaken on the basis of a competitive bid for funds from industry or agency. It is anticipated that the research will result in a deliverable product or report of commercial importance.

Sponsored research

This is a mode of research in which granting agencies advertise a call for applications and the applications are normally peer reviewed. Sponsored research projects are either basic or strategic but are normally concerned with commercial outcomes.

Consultancy

This type of project involves buying the skills and expertise of specialists as well as infrastructure to work on a specified project.

TYPES OF RESEARCH

The criteria for classifying types of research include:

- Methodology
- Approach
- Function/purpose
- Discipline-based
- Others

Methodology

On the basis of the methodology used in carrying out a study, research can be grouped into the following.

Qualitative Research

Qualitative research involves collection of narrative data in a natural setting in order to gain insights into phenomena of interest. This type of research studies many variables over an extensive period of time in order to find out the way things are, how and why they came to be that way, and what it all means. Qualitative researchers do not want to intervene or control anything. The most common methods of data collection are observations, interviews and focus group discussions, in order to guide and support the construction of hypotheses. The results of qualitative research are descriptive rather than predictive.

Several unique aspects of qualitative research contribute to rich, insightful results due to

- synergy among respondents, as they build on each other's comments and ideas;
- the dynamic nature of the interview or group discussion process, which engages respondents more actively than is possible in more structured survey;
- the opportunity to probe ("Help me understand why you feel that way") enabling the researcher to reach beyond initial responses and rationales;
- the opportunity to observe, record and interpret non-verbal communication (i.e. body language, voice intonation) as part of a respondent's feedback, which is valuable during interviews or discussions, and during analysis;
- the opportunity to engage respondents in "play" such as projective techniques and exercise, overcoming the self-consciousness that can inhibit spontaneous reactions and comments;
- the social world being complex, multidimensional. Qualitative research has the strengths of understanding context, diversity, nuance, and process.

What are the "difficult questions' that qualitative researchers need to ask themselves and to resolve in the process of doing their research?

- Through qualitative research, we can explore a wide array of dimensions of the social world, including the texture and weave of everyday life, the understandings, experiences and imaginings of our research participants, the ways that social processes, institutions, discourses and relationships work and the significance of the meanings that they generate (Mason 2002, p.1).
- Qualitative research methodologies celebrate richness, depth, nuance, context, multi-dimensionality and complexity. Instead of editing these elements out in the search of the general picture or the average, qualitative research factors them directly into its analyses and explanations (Mason 2002, p. 1).
- It has capacity to constitute how things work in particular contexts. It recognizes strategic significance of context, and of the particular. It is not merely anecdotal or illustrative, and does not employ casual and unsystematic ways.
- There is greater emphasis on holistic forms of analysis and explanation, than in charting surface patterns, trends and correlation. Qualitative research does use some forms of quantification, but statistical forms of analysis are not seen as central.

Furthermore, qualitative research can help you to
- develop hypotheses;
- understand the feelings, values, and perceptions that underlie and influence behaviour;
- identify customer needs;
- capture the language and imagery customers use to describe and relate to a product, service, brand, etc.;
- generate ideas for improvements and/or extensions of a product, line , or brand;
- uncover potential strategic directions for branding or communications programmes;

- understand how people perceive a marketing message or communication piece;
- establish parameters (i.e. relevant questions, range of response) for a quantitative study;
- explore specific information obtained in a quantitative study, to better understand the context and/or subtext of the data;
- come to an understanding of the nature, function or/ and aesthetics of a cultural phenomenon, human condition, social philosophy or literary theory.

Some situations where qualitative research is often used include the following:

- New product development
- Investigating current or potential product/service/ brand positioning and marketing strategy
- Identifying new uses for current products
- Identifying strengths and weaknesses
- Understanding purchase decision dynamics
- Developing or evaluating advertising or public relations campaigns, other types of marketing communications, graphic identity/branding, package design, etc
- Probing opinions of current societal or public affair issues
- Assessing the usability of websites or other interactive products or services
- Understanding peoples' perceptions of a company, brand, category or product idea
- Pre-quantitative survey – developing hypotheses to be covered in structured questionnaires, in the respondent's language
- Post-quantitative survey – in-depth exploration and interpretation of quantitative findings
- The processing or analysis of a body of works or ideas which have developed over time and which demand closer scrutiny

Nonetheless, you should not expect qualitative research to

- count, measure or offer statistical validation,
- determine the most effective or desirable product concept or price point, or establish importance of specific customer needs or satisfaction criteria,
- substitute for quantitative research because of time and/or budgetary constraints when quantitative evaluation is critical.

Unstructured observation
The researcher becomes part of the action being studied but that role is not always obvious although it is unethical to participate without telling the other participants. The researcher participates in the activities of a group to experience what the group experiences and can observe hard data as well as reflect upon the experience. It is usually qualitative. e.g. a student studying religious rituals might attend and join in a service in order to understand better what is involved. It can be participant on non-participant.

Semi-structured Interview
This can be either quantitative or qualitative, depending upon how many people were interviewed and the similarity, if any, of answers. It is where we have certain key questions that determine the direction of the interview but we allow enough flexibility to ask new questions based on the response we get and allow the interviewee to give some shape to the content. It is often used when institutions seek guidance on how they can structure their services better. It can also be used when interviewing a contained number of people on the same topic.

In-depth interview (IDI, one-on-one)
We interview a single individual and allow time and freedom to explore issues at length. Unlike a survey, we do not end up with a generalization about a large group but we record and analyse the specifics about a small number of people. The mode of interview will depend on the research objectives, target market, timetable, and budget for a particular project.

- Personal/executive interviews may be most appropriate for in-depth interviews within a specified industry segment but typically are the most expensive.
- Telephone surveys may be cost-effective if a large number of interviews are required in a short period of time. Calls may be made to a targeted list or using a random dialling procedure.

Dyads, triads
In-depth interviews with two or three people who often represent members of the same family or business team, who use a product or service and/or make purchase decisions together.

Focus group
This involves a small group (three to eight people) who are together for an in-depth discussion on a specific issue. This is like an in-depth interview but using a group rather than an individual. It is qualitative enough although this does not stop us using and discussing statistics. It is very useful when trying to analyse an issue (three to eight heads are better than one) or looking for the experiences/beliefs/feelings of a group. The researcher plans a set of interview questions designs and a guide, tapes the discussion and transcribes the findings. A moderator sits in to take the notes, and in the process observes features like the mix of the group being interviewed (age, sex, etc) and the interactive process (e.g. who is reticent, who is easily drawn out). It should be pointed out that some of these observations might not be readily obvious from a tape recording of the interview.

While focus groups have historically been held in person (face-to-face), they can also be conducted remotely by teleconferencing, by videoconferencing, or through the Internet using text chat, online bulletin boards, online collaboration tools, desktop video conferencing, or various forms of tele/web conferencing.

It is useful to integrate qualitative and quantitative research methods.

Quantitative Research
Quantitative research involves gathering information in numeric form. It differs from qualitative research in the following ways:

- The data is usually gathered using more structured research instruments;
- The results provide less detail on behaviour, attitudes and motivation,
- The results are based on larger sample sizes that are representative of the population,
- The research can usually be replicated or repeated, given it high reliability; and
- The analysis of the results is more objective.

Quantitative and qualitative research are often complementary and in a research design both may feature. The qualitative element frequently takes place at the front end of the study exploring values that need measuring in the subsequent quantitative phase. The "qual" research may offer a diagnostic understanding of what is wrong while the "quant" research provides hard data across different respondent groups that can lead to specific recommendations with measures that can be used as controls to determine the effectiveness of actions.

Statistical/data analysis using existing material
In this case, the researcher already has the results of someone's research but he needs to work out what it means and its significance. e.g. can be used when comparing birth and death rates between countries.

Structured observation
This could also be participant or non-participant. It is used when we observe recurring events or behaviours and make a note of what we see for later analysis. The researcher is not part of the action being observed. It is often used when Councils want to see how frequently and for what purposes their facilities are used. It is quantitative. e.g. How many people use this park and for what purpose is it being used? How many people use this road on their way to work?

Survey research

It is the process of conducting a study of specific groups or populations. There is a variety of styles such as close-ended questionnaires, structured interviews and observation using data recording sheets. A researcher could use surveys to find out his/her own set of statistics or data. You could also employ multiple choice questions, Lickert scale questions and open-ended questions to ensure that we are comparing apples with apples.

Sample range and size are critical factors. This method will give a rapid picture of overall trends.

Survey research is used for many different applied purposes, e.g.:

- to help select the behaviour to be changed by an intervention
- to choose the target population best suited for an intervention
- to profile a population
- to determine the best channel to reach a population

Mail surveys may be appropriate if the subject matter is more personal in nature or requires lengthy descriptions. Newer methodologies such as on-line and e-mail surveys may be appropriate for hard-to-reach audiences with the appropriate technologies.

Approach

Descriptive Research

Descriptive research tells "what is". No manipulation of variables is attempted, only descriptions of variables and their relationships as they naturally occur. Descriptive research answer questions like "What do entry level bank cashiers know about customer satisfaction?" As with causal-comparative studies, there is no control of variables as in experimental research. Descriptive research methods range from the survey, which describes the status quo of variables, to the correlational study, which investigates the relationship between variables.

Correlational Research
Correlational research determines whether, and to what degree, a relationship exists between two or more quantifiable variables. Suppose you had collected data on at least two variables for the same group of subjects, you could then calculate a correlation coefficient between the variables. This correlation coefficient (indicated as r) may have a value from -1.00 though 0.00 to +1.00. A value of 0.00 would indicate no correlation, while a value of -1.00 or +1.00 would represent perfect correlation between variables. Caution should be exercised in trying to conclude that correlation means causation; there may be a third factor which causes both of the related values.

Causal-comparative Research
Causal-comparative research is used when you cannot test a hypothesis by manipulating a variable. This type of research allows you to investigate relationships in which variables like intelligence, creativity, socioeconomic status, and instructor personality cannot be manipulated. For example, suppose you wanted to test the hypothesis that students from lower socio-economic groups benefit more from on-line virtual libraries as compared to those in higher socioeconomic groups, you would use causal-comparative research because you cannot assign students to a particular socio-economic group.

Experimental Research
In its simplest form, experimental research has three characteristics:

- an independent variable is manipulated,
- other variables except the independent variables are held constant (experimental control), and
- effect of the manipulation of the independent variable on the dependent variable is observed.

We can think of the independent variable as the cause and the dependent variable as the effect. We hypothesize that the value of the dependent variable depends upon, and varies with the value of the *independent* variable.

For example, to examine the effect of different font sizes on reading speed, you might randomly select 30 people and time how long it takes to read a passage of text in 10 point font size, while another group of 30 reads the same passage in 12 point font. You manipulated font size, the independent variable, and measured the effect upon reading speed, the dependent variable. The essence of experimentation is control.

Function/purpose

Adaptational Research/Implementational research

This is the stepping up of research results to the level of immediate application for achieving specific practical goals.

Action research

This is a method that involves the researcher in joining in the activities of the group being studied. Usually, it is informal, qualitative, interpretive and experimental. It is often used when people see a problem in a situation and, by becoming involved in the activities of the group, are able to experience the problem and work out solutions. It involves

- identifying the problem,
- observing how people cope with it,
- trialling, and then
- evaluating solutions.

It can involve a high level of participation and experimentation. It is the natural way of acting and researching at the same time.

act ⟶ review ⟶ act ⟶ review

This is the natural cycle which action research uses to achieve its twin outcomes of action (for example, change) and research (for example, understanding). You might say that action research is true to label – it is action and research.

Some features of action research assist the action. Some assist the research. Some assist the "and" – they help the action and the research fit together.

Intervention Studies

This is conducted, for example, to evaluate the impact of specific interventions on the prevention of disease, often in the context of community-based intervention trials or in modifying the clinical course of disease, often in the context of clinical trials. It could also be employed to assess whether or not an intervention is effective in changing the targeted behaviour (behavioural intervention research).

Formative research

This is research conducted to understand behavioural, structural or systematic factors that influence decisions and actions.

Social marketing and Communications research

This is research undertaken to ensure that marketing decisions are empirically based.

Operations research

As understood today, operations research is essentially identical to systems analysis. Historically, it was a narrower area of activity that stressed quantitative methods and did not concern itself with 'trade offs' between objectives and means or with problems of equity. It is defined by the Operational Research Society of Great Britain as "the attack of modern science on complex problems arising in the direction and management of large systems of men, machine, materials and money in industry, business, government and defence". Its distinct approach is to develop a scientific model of the system, incorporating measurements of factors such as change and risk, with which to predict and compare the outcomes of alternative decisions, strategies or controls. The purpose is to help management determine its policy and actions scientifically.

Discipline-based research

Clinical research

This is often conducted with patients in a medical setting such as a hospital and is designed to obtain better information on the natural history or pathogenesis of a condition that may lead to improved strategies for diagnosis, treatment or prevention of a disease.

Epidemiological research
This usually involves population–based investigations which may be cross-sectional surveys of selected populations (case control studies) or all members of a community, or may involve longitudinal study of a population over time (cohort studies). Such research is conducted to obtain an improved understanding of the natural history of a disease or to identify factors that increase or decrease the risk of disease in individuals.

Social and behavioural research
This is often a component of epidemiological research and focuses on the study of behavioural and social factors that may modify risk of disease in individuals or in populations.

Other types of research
Case study
This could be either quantitative or qualitative depending on whether you use numbers or not. It usually involves collecting data or observations of a person or small group through observation, interview and documentary evidence. A quantitative case study could be a study of the family in Nigeria when you use actual statistics and it could be qualitative if you explore the significance of family as a socialising agent by doing a series of in-depth interviews with a limited number of people.

Pilot study
This is largely a preliminary study to a major study.

Replicative research
This could involve a model/technique that has been used elsewhere and is to be tested in order to ascertain whether it would yield the same or different results in a different context.

Content analysis
This involves analysing, evaluating and interpreting written and visual material. It could be used for a newspaper analysis, media analysis, magazines, photos, TV, etc. It is often qualitative but it can be quantitative, for example, when analysing the amount of time devoted in TV programming to certain issues, or the frequency of occurrence of a particular film or action.

Personal reflection
In this type of research, we reflect upon, explore and evaluate our own experiences. This can be an important qualitative method that asks the researcher to evaluate his own memories, values, experiences, understandings and opinions on an issue. It involves a fair degree of personal involvement, e.g. a researcher's experiences as an exchange student. It is more of a factor in analysing research data.

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2

THE LINK BETWEEN EVERYDAY REASONING, SCIENTIFIC REASONING, SCIENTIFIC RESEARCH AND THEORY

S. A. Babarinde

INTRODUCTION

Man is constantly in interaction with his world. As a result of that interaction he acquires diverse information about himself as well as about the external world. These include, the world of animals, plants, other living and non-living things, both physical and abstract, including the terrestrial planets/ objects.

Ever since man emerged from the primitive stage into his current civilised status, he has had to wonder about the information he constantly receives from his environment. Whenever he, therefore, exercises faculty or power of reason to draw conclusions or inferences from facts of experience or premises, he is said to be engaged in reasoning. So, reasoning is as old as man. It is a major existential reality of man. But reasoning has not always been conducted in similar or uniform manner since topics are diverse and interests and goals vary. The following questions can be asked:

- What constitutes reasoning?
- What are the various ways of conducting reasoning?

- What is the difference between everyday reasoning and scientific reasoning?
- What is the relevance or link between scientific reasoning and scientific research?
- What are the implications of these questions for development of theory?
- And what is the relevance of all these to human progress and development?

These, among similar questions, are of interest to us in this Chapter as we shall show below.

MAN AND KNOWLEDGE

The Question: What is man? can be answered in several ways. For example, man is a living being, man is a higher creature, he is a speaker of words and doer of deeds (Homer), he is a political animal (Aristotle) and so on. Without going into the complex ontological theory of man which has occupied the attention of philosophers over the ages, the consensus seems to see man as a thinking or reasoning being – that man reflects over his experience. He doubts, affirms, re-examines, criticises, synthesises, conjectures, interprets, contradicts, analyses and so on. Whenever he does any or combination of these, he is said to be thinking or reasoning, that is, he is using his intellectual capacity to understand his world based on the plethora of information available to his senses. As a result of this preoccupation with thinking and reasoning, man is seen and understood in terms of reasoning, that is why the French mathematician and philosopher, Rene Descartes, came out with widely quoted statement, *cogito ergo sum,* meaning, I think, therefore I exist which presents man's existential reality in terms of the ability to reason. In this, Descartes has followed the footsteps of his philosophical predecessors such as Socrates, Plato and Aristotle among others who also equally see man's chief characteristic as the ability to reason. But what is the whole essence of this preoccupation with thinking or reasoning? Man engages in reasoning in order to acquire knowledge which the Greeks call *episteme* and from where epistemology – theory or nature of knowledge got its name.

What then is it to know? Knowledge is acquired through various sources. These are described as types or sources of knowledge. An examination of these if only briefly will assist us in identifying what constitutes reliable knowledge through reliability in reasoning.

- **Knowledge through Acquaintance**
  - Knowledge derived through casual physical contact with an item of knowledge. This type of knowledge is akin to hearsay whose reliability is highly limited with its grounds not being very reliable and therefore reasoning based on this is bound to be severely limited.

- **Knowledge by Description**
  - Knowledge through a close contact as a result of which a certain level of description of characteristics of the item of knowledge can be rendered. Reasoning based on this leads to testimonial and circumstantial evidences for example. The shortcomings of this type of knowledge, however, have been its major limitation. For example, the description A can render of an object may not tally with that of B based on differences of interests and goals.

This is why reasoning based on knowledge by description is often held with caution as it is easily influenced by sentiments and prejudices of the person giving it.

- **Knowledge by Revelation**
  - This is knowledge through some divine source usually associated with religions. Reasoning based on this depends on spectral evidence by ghosts, spirits and other paranormal or supernatural entities. Apart from the fact that this type of knowledge is highly private and not open to others, its claim rests on the existence or validity of the paranormal or supernatural entities from where it derives its claim. Although this is a widely used form of knowledge on which a lot of reasoning is based, its claim is highly limited.

- **Knowledge by Intuition**
  - This is knowledge based on sudden insightful solution to a problem and which is said to be generated from the sub-conscious level of the mind. Many inventors, scientists, innovators and other highly creative individuals lay claim to this form of knowledge. Despite this, its grounds are controversial because it is so private, subjective and not open to others no matter how interested they may be.

    - It is in this connection that the renown chemist August Kekule cautions, *let us* *learn to dream, maybe we shall discover the truth but let us also learn not to publish our dreams until they have been examined by wakened minds.*

- **Knowledge by Tenacity**
  - This is knowledge claim that had been repeated overtime that is has become an article of faith to which the claimant becomes emotionally attached. But incidentally, emotional claims or attachment does not substitute evidence or proof and therefore reasoning based on it has to be shown to be unreliable. Human tragedies have been linked to this type of reasoning. For example, the Jewish Holocaust, the trans-Saharan slave trade and the apartheid policy in Southern Africa were all based on emotionally assumed racial superiority of the dominant culture.

- **Knowledge by Authority**
  - This is an age long type of knowledge where the authority may be represented by parents, elders, experts, textbooks, scriptures, cultures and so on. Reasoning based on this rests on the assumption that reliable knowledge is what the authority says it is. The weakness of this, however, is that many authorities are not reliable and so the need to recheck the reliability of any authority before one accepts its evidence. Reasoning based on the evidence of authorities has been very common among human beings because one, we are all brought up

from birth by parents who use their vantage positions as authority figures and use positive and negative reinforcements to make us listen to, believe and obey authorities; second, it has become widely believed that human societies that make use of specialisation and division of labour and thus rely on the guidance of a few highly trained and experienced authorities to make decisions that affected all had a higher survival value than others who ignored this rule, and as a result, this was passed along to future generations through the process of natural selection. Third, knowledge by authority is about the quickest and efficient method of transmitting existing information or knowledge. Despite the above attraction and claims of reasoning based on authoritarian knowledge, there is always the need to verify the claims of the authority as according to Socrates, *the unexamined life is not worth living*. Man, therefore, needs to be his/her own authority at the end.

- Research works rely so much on evidence by authorities and it is inconceivable to imagine landmark achievements outside the accumulated knowledge of authorities. This is one of the rationales for literature review in research. However, the evidence of authorities has to be subjected to review through criticisms, analysis and synthesis before they are assumed to be worthwhile. It is a common mistake among young researchers to simply compile long lists of quotations and paraphrases from existing literature as their chapter on review of related literature. This is clearly not the requirement as this can simply be described as *scissors and paste* history with very limited usefulness. Even historians of contemporary age speak of scientific history which is a rejection of that sort of uncritical approach to their discipline.

- **Knowledge through the Senses or Empirical Knowledge**
  - This refers to knowledge acquired through human perception of seeing, hearing, feeling, taste and smell. It is common and available to almost all normal human beings. Although, high premium is placed on knowledge through the senses, differences between the way things appear to us and the way they are in reality constitute strong signal for caution. Our perceptions of objects are often defective or distorted depending and our state of health and previous experiences. For examples, one suffering of malaria fever will report distorted temperature and taste of food and another with defective sight will give inaccurate report of distance, size, colour, and number.
  - Some notable philosophers such as Kant have suggested that human perception should not be regarded as absolute evidence on which to base our reasoning but these should be examined in line with other relevant and available sources of knowledge.

- **Knowledge through Reason**
  - This is knowledge acquired through the application of our reasoning and power of inference. It is sometimes referred to as logical knowledge since its use rests on rules of logic. Whereas everyone makes claim to reasoning, not everyone conducts valid reasoning because thinking or reasoning can also become distorted as a result of sentiments and prejudices.

One major lesson from the above analysis is that we must develop some sense of scepticism and be critical of knowledge claims. Knowledge demands evidence, it is tentative and open to investigation. Knowledge claims should be verifiable and it should be possible to falsify them with available evidence. Knowledge grows and it is said to be on a continuum, that is, there is no point at which one can claim to possess all the knowledge just as it is difficult to find a normal person who is totally ignorant or lacking in all knowledge. This is a major lesson of philosophy which demands a continuous search for knowledge, a challenge which research and researchers have embraced.

THE SEARCH FOR TRUTH

Attempt to understand the nature of the phenomena is presented to man through three based categories namely: Experience, Reasoning and Research. Wherever the layman bases his 'theory' on haphazard events and uses them in a loose and uncritical manner and in testing, he does so in a selective fashion. Often he chooses only the evidence that is consistent with his hunches and ignoring that which is counter to them. On the other hand, the Scientist constructs his theory carefully and systematically. His hypotheses have to be tested empirically so that his explanations have a firm basis in fact. Concept of "control" distinguishes the layman's and the scientist's attitude to experience (control is of extraneous sources of influence when trying to explain an occurrence).

Three types of logical reasoning can be identified. These are: Deductive reasoning, Inductive reasoning and Inductive – deductive approach.

- ***Deductive reasoning.***
  - Deductive reasoning is based on the syllogism of Aristotle (formal logic) – a major premise based on an *a priori* self-evident proportion, a minor premise providing a particular instance and a conclusion e.g.

All plants orbit the sun; the earth is a planet; therefore, the earth orbits the sun. The assumption behind syllogism is that through a sequence of formal steps of logic, from general to particular, a valid conclusion can be deduced from a valid premise.

- ***Inductive reasoning***
  - This assumes that the study of a number of individual cases would lead to a hypothesis and eventually to a generalisation. Its premise is that if one collected enough data without any pre-conceived notion about their significance and orientation – thus maintaining objectivity - inherent relationships pertaining to the general case

would emerge to be seen by an alert observer.

- *Inductive – Deductive*
  - This is a combination of the two previous approaches to reasoning. Contributions of deductive – inductive logic to Science include: suggestion of hypotheses, logical development of these hypotheses and clarification and interpretation of scientific findings and their synthesis into a conceptual framework.

SCIENTIFIC AND CRITICAL REASONING

The search for reliable knowledge through valid reasoning led to the development of what is known today as scientific or critical reasoning. Scientific method is based on scientific thinking or reasoning and it is used interchangeably with critical thinking or reasoning. This seems to suggest that critical reasoning belongs only to the scientists. This is not correct. Indeed, anyone can think or reason critically as long as s/he is trained in the precepts or steps of critical reasoning. This method of reasoning is applicable to a wide range of subjects like the natural sciences, the social sciences, history, literature and philosophy. Whenever one is seeking solution to questions relating to man, knowledge and values whether in oneself or others or generally about the nature of existence – both ontological and cosmological through a reliable method, critical reasoning becomes indispensable. Whereas scientific reasoning is used to describe the form of reasoning practiced by the scientists, critical reasoning is used to describe a similar method when used by other humans in other fields of study. Although this method of reasoning appears to be most popular with the scientists today, it was neither invented nor developed by them. We owe that great achievement to the ingenuity of ancient Greek philosophers.

Notable names in this tradition include Thales who was famous for predicting an eclipse which according to the astronomers must have taken place in 585 B.C., Anaximander born in 482 B.C. said to be the first man to make a map and held that earth is shaped like a cylinder. He was original, scientific and rationalistic; Pythagoras c. 570 – c. 497 B.C. founder of a school of mathematicians; Herodotus who lived around 500 B.C. and famous for his doctrine that everything is in a state of flux; Parmenides native of Ela who flourished in the first half of the fifth century B.C. He was said to have invented logic-method of valid reasoning and distinguished between the way of truth and the way of opinion; Empedocles who lived around 400 B.C. and taught the doctrine of the four elements, and in the use of the two elements of LOVE and STRIFE to explain change. He also regarded nature to be regulated by chance and necessity rather than by purpose. In that tradition is also Anaxagoras c. 500 BC – c. 428 B.C., first Philosopher to teach in Athens about 480 or 465 BC. He sought a higher cause, independent of matter, and found it in *Nous* i.e. mind or intelligence. It was *Nous*, not blind forces that acted upon matters, caused motion and change and produced the rationally ordered cosmos that is evident in the universe's design, order and harmony. His pupils included Pericles, Euripides and possibly Socrates. Others include Plato and Aristotle. Russell (2000).

The rudiments of this method may be found in the dialectics employed by Socrates as recorded by his foremost student and disciple-Plato in the dialogues such as *Crito*. *The Republic*, *Phaedo* and others. The method was practiced in the *Academy*-the first University in recorded history established by Plato and Aristotle known as the first major

Scientist equally made significant contributions in the development of this method.

The method was popularised in the 17th and 18th centuries by the scientists. It has since become the most reliable and successful method of reasoning in human history. It is for this reason that critical reasoning which is otherwise known as scientific reasoning has been adopted for research in diverse areas of study or investigation. What then constitutes scientific or critical reasoning? Scientific or critical reasoning is not simply about research questions, observations, data, hypotheses, testing and theories. These are only the formal or technical parts of the scientific method. Although they are important, they do not constitute the most important aspects of the scientific or critical method or reasoning. The characteristics of scientific method include the following;

- Use of empirical evidence (Empiricism);
- Practicing logical reasoning (Rationalism) and
- Possessing a sceptical attitude (Scepticism).

Empirical evidence refers to evidence from what one can see, hear, touch, taste or smell or evidence from the senses. This sort of evidence is open to others and can thus be cross-checked. Empiricism rests on the philosophy of naturalism which claims that reality and existence, that is, the universe, cosmos or nature, can be described and explained only in terms of natural evidence acquired through the senses. This tradition is also known as positivism or the acceptance of natural sciences as paradigm of human knowledge. Its assumption was given by Giddens (1971) that the methodological procedures of natural sciences may be directly applied to the Social Sciences. That the Social Scientist thereby becomes an observer and that the end-product of his investigations can be formulated in terms of parallels to those natural sciences and the analyses in laws or law-like generalisations. August Comte further reinforced positivist tradition in the Social Sciences. He argued that genuine knowledge is based on sense experience and can only be advanced by means of observation and experiment. Empiricism or positivism is, therefore, the abandonment of metaphysical and speculative approaches for knowledge by reason alone.

The practice of logical reasoning or rationalism is the use of systematic and valid method of reasoning based on the rules of logic. It includes deductive reasoning, inductive reasoning and inductive – deductive reasoning as earlier explained. Human beings are not born with logic and it is not just acquired through experience and maturation. Logic as a skill or discipline has to be learned within a formal educational environment. Other forms of thinking such as wishful thinking, emotional thinking and hopeful thinking are much more common, easier and popular but they do not lead to reliable knowledge. Logical reasoning requires painful submission to the truth whatever and wherever it may be. Scepticism is to possess sceptical attitude about presumed knowledge and this leads to consistent self-questioning, holding of tentative conclusions and being undogmatic which includes readiness to change one's beliefs in the face of valid evidence.

RESEARCH

Critical or scientific reasoning and method are indispensable in research which has been defined as systematic, controlled, empirical and critical investigation of hypothetical propositions about the presumed relation among natural phenomena (Kerlinger, 1986). Three characteristics of research include the fact that, first, research is systematic and controlled, basing its operations on the inductive-deductive model against experience whose event occur in a haphazard manner. Second, research is empirical; that is, experience is used for validation. Subjective belief must be checked against objective reality. Third, research is self-correcting, there are in-built mechanisms to protect the scientist from error and his procedure and results are open to other professionals through allowing for revision or rejection of incorrect result in time. Fourth, research is a combination of experience and reasoning and it is regarded as the most successful approach to the discovery of truth as far as the natural sciences are concerned.

Scientific research leads to the formulation of scientific theories. Kerlinger (1986) defined theory as, "a set of interrelated constructs (concepts), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables with the purpose of explaining and predicting the phenomena." A theory thus gathers together all the isolated bits of conceptual frameworks for wider application. Scientific theories such as theories of evolution, plate tectonics, quantum mechanics, relativity, thermodynamics, big bang cosmology among others represent the most rigorous, most reliable and most comprehensive form of knowledge. Similar reliable theories could be found in the social sciences and humanities and they all constitute the rich human heritage.

Knowledge is transferred from one generation to another through the commitment and devotion of lovers and seekers of knowledge and wisdom especially through research. History of civilisation is also the history of knowledge. Civilisation is also about man – man is the subject – matter of knowledge and development.

CONCLUSION

In conclusion, we need to understand the concept of unity ofknowledge which research through critical or scientific reasoning and method have made possible. The search for knowledge started by lovers of wisdom or knowledge and these people were known as those engaged in *Philo* and *Sophia* or love of knowledge, and that is how the term philosophy came to describe what is today known as research. Indeed, the term science and scientists had been identified as 17th Century American invention which was initially regarded by philosophers of nature as derogatory. It is the retention of that tradition that makes the postgraduate schools of universities to award the degree of Doctors of Philosophy (Ph.D) in various disciplines. The forms of research that lead to the formulation of theories are conducted in all disciplines. There are also forms of research that lead to scientific inventions. The same factors that may lead to the preparation of conceptually incompetent researchers explain the rash tendency of some researchers to rush into building a lifetime of research on a weak conceptual or theoretical foundation. For example, the false doctrine that assumes that the only correct way to define terms is the so called "operational definitions" or that of irresponsibility in definitions generally.

And so, the point needs to be made that the attempt to make rigid separation between forms of research and to proceed from there to condemn or ridicule certain forms of search for the truth or knowledge is unenlightening and portrays the non-wisdom of the sort of black or white reasoning with all its limitations. We do know at least that between black and white there are several shades of grey. There is hardly a strictly scientific or logical research. The designing, execution and interpretation of research in the scientific tradition demands the application of reasoning throughout, and indeed they rest on certain logical grounds. In the same vein, logical inquiry has to utilise all available evidence including the empirical/scientific ones before any valid conclusion can be made. The unity of knowledge, therefore, demands humility, open-mindedness and painstaking commitment to discover the truth, which marks the age–old commitment of great philosophers. They lived, suffered and sometimes died for that commitment. On this note of the need to recognise and respect unity and validity of knowledge, we shall conclude with an insightful thought of a writer, who cautions that:

> *An excellent plumber is infinitely more admirable than an incompetent philosopher. The society which scorns excellence in plumbing because plumbing is a humble activity and tolerates shoddiness in philosophy because it is an exalted activity will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water (Gardener, 1961).*

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3

DESIGN AND DEVELOPMENT OF CONCEPTUAL FRAMEWORK IN RESEARCH

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BACKGROUND

A research project is a systematic, structured study to address a specific problem. The research process involves:

- identifying the problem,
- examining selected relevant variables,
- constructing a hypothesis where appropriate and possible,
- constructing a research design,
- conducting experiments to test the hypothesis,
- collecting relevant data,
- analysing the data,
- discussing the results and then
- drawing appropriate conclusions.

A research project should not be considered as completed until the findings have been disseminated to the appropriate audience. Badiru (1996) identified the following critical elements for a successful research work:

- Conceptual and theoretical frameworks,
- Research hypothesis: Specify the research questions to be addressed,

- Define problem scenario: Explain the situation relevant to the problem,
- Research goal: Specify what is to be done,
- Research design: Develop a plan to carry out the research,
- Implementation: Carry out the research,
- Conclusion: Draw conclusions from the results,
- Documentation: Report the findings.

IMPORTANCE OF CONCEPTUAL FRAMEWORK

A concept is an idea or an abstract expression of something and a framework is a supporting structure around which that concept can be built. Many scientific discoveries that have had profound effects on mankind and society can be linked to nature, literature and the physical, chemical and biological sciences. For example in John Keats's "Ode to the Nightingale", the motion of the albatross has a conceptual similarity to the physical description of the aeroplane. Thus, concepts in one area can lead to momentous discoveries in another apparently unrelated field. The framework of knowledge has once been described as a capsule moulded to form a particular shape for ease of swallowing. It has also been described as an anthill with irregular protrusions from which tangential developments can be made. Both definitions can be understood to mean focusing of ideas and efforts to achieve a particular goal. Research work leads to the understanding of the micro-systems or the entrails of the framework of knowledge. In the sciences, this is particularly important as shown by the following examples:

(i) The study of meteorology graduated from collecting physical data on the ground for long-time plans to air-borne real-time analyses and prediction to support the aviation industry whose operations are greatly affected by atmospheric pressure variations and weather. The framework is aviation industry as a commercial venture. The research is the conquering of the environment where it operates.

(ii) The insurgence of physics, mathematics and electronics into medicine emanates from the need to avoid subjective analyses and reducing damage to human cells (and body) by making in-situ assessments without recourse to unnecessary surgical operations, e.g. x-rays, scanning techniques etc. This is the framework. The research is the application of electronics to make diagnosis.

(iii) The need for long-term and long-distance communication links led to radio, satellite, and of course, GSM industries via the use of electromagnetic (EM) waves. The tangential gains are reduction in cost (no need for wires and cables, and less human supervision and maintenance). The generation, transmission, modulation, and receiving of signals from the research entrails. The framework is the use of EM waves for communication and transfer of data – a feat that was achieved within a period of 100 years.

As indicated above, the whole essence of a framework is the focusing of ideas and efforts to achieve a particular goal. The Ph.D. research should be guided by some explicit theoretical or conceptual framework without which the thesis becomes a "mindless theoretical wasteland" (Adams and White 1994). The seven critical elements for a successful research earlier mentioned (Badiru 1996) should be captured in the conceptual framework highlighting a set of activities which are necessary for proper research project formulation and implementation. These activities include:

- Description of the prevailing situation indicating the key problem which the research project is expected to solve;
- Provision of a mechanism for addressing the problem;
- Establishing research goal and objectives;
- Establishing formal systems for carrying out the research project;
- Establishing mechanisms for dissemination/application of the expected output.

DISTINCTION BETWEEN THEORETICAL AND CONCEPTUAL FRAMEWORKS

In the Social Sciences, both theoretical and conceptual frameworks have their relevance. Social scientists generally are committed to understanding the social world and the place of man in it. Phenomena such as armed robbery, prostitution, maternal mortality, political instability, environmental degradation, inflation, aggression etc are comprehensively understood through different explanatory models. Theoretical framework is the explanation of a particular phenomenon using relevant theory/theories. This statement supposes that existing theories are employed in that enterprise insofar as each of the ones adopted provides at least a modicum of insight into the thematic subject. Most studies that adopt more than one theoretical position in explaining events do so due to their complexity. Researchers are expected to explain whatever phenomenon they are interested in, only from extant theoretical perspectives.

The difference between theoretical framework and conceptual framework is that whereas the former provides a "disarticulated", guided and inconclusive explanation of a social reality, the latter synthesises various theoretical perspectives (a kind of unity in diversity is emphasised) leading to a brand new framework which belongs wholly to the researcher and which is designed to solve the problem at hand. The implication is that conceptual frameworks are meant to be original and peculiar to a particular study. It simply means the theoretical "conception or perception" of a researcher holding all other theories constant. As a corollary, as there are many researchers working on the same subject, so also are conceptual frameworks meant to be many. Hence, duality of conception or perception is very rare among social scientists. In many cases, conceptual frameworks are usually explained using diagrams to highlight the links between the dependent and independent variables. It is important to note that conceptual framework is also possible even in a situation where a researcher had used only one theoretical view-point. The onus is then on him/her to extend that perspective using the instant study.

The relevance of theoretical and conceptual frameworks in the social sciences is in their ability to activate research into a specific problem by guiding a researcher along the path of scientific enquiry on the one hand. On the other, when research precedes theoretical and conceptual frameworks, the latter serves to provide a deeper explanation to study findings. With a proper understanding of a situation, a researcher is better equipped to arrive at valid conclusions and the extension of knowledge generally. In sum, frameworks challenge the manipulative skills of social scientists and provide the impetus for contributing the technical interest of the social sciences.

DISTINCTION BETWEEN CONCEPTUAL FRAMEWORKS AND RESEARCH DESIGN

Research design is different from design of conceptual framework. Research design is the plan containing the *structure* and *strategy* of investigation that are conceived in order to obtain answers to research questions, and to control variance (Kerlinger 1973). As the plan of research, it provides the general scheme to be followed in a research. This includes an outline of what the investigator will do, beginning from the statement of the hypothesis of the study to their operational implications and the analysis of data.

A research design encompasses both the *structure* and the *strategy* for conducting a study. As a structure, the research design provides a specific outline, scheme, and paradigm of operation of the variables. In some cases diagrams are drawn that outline the variables and their relation and juxtaposition. In sociological, psychological and educational research, these variables often include sex, income, education, social class, organizational productivity, introversion, verbal aptitude, political preference, authoritarianism, and achievements. This structural part of research design is what is referred to as the conceptual framework. Conceptual framework is therefore, the initial stage of research design.

As a strategy, the research design also provides more specifically, the methods to be used in gathering and analysing data. In other words, it indicates how the research objectives will be accomplished and how the problems encountered in the research will be tackled.

Invariably, the starting point of any research project is the identification and articulation of the problem that the research is to address. The Ph.D. research problem should not be merely a 'problem solving' one but should 'test out' the limits of previously proposed generalizations (Phillips & Pugh 1987). Asking the familiar questions 'who', 'what', 'where', 'how' and 'why' may help the Ph.D. candidate set appropriate boundaries around the research problem, within which the data and the conclusions of that particular Ph.D. research should apply. The next stage is designing and developing a conceptual framework for providing a solution to the problem. This invariably may require the following (Olorunnisola 2003):

- Constructing and clearly defining the hypothesis, specifying the research questions to be addressed and the expected outcome.
- Constructing operational definitions by converting variables from an abstract or conceptual form to an operational form that makes them available for manipulation, control and examination.
- Constructing a research design i.e. specifying operations for testing the hypothesis under a given set of conditions.
- Identifying and constructing devices for observation and measurement.
- Identification of avenues for dissemination of findings.

Though it is generally agreed that a research design is a plan that shows how a study will be conducted, researchers and evaluators are not agreed on the specific elements or components that should be included in it. In evaluation research, research design can be conceptualized as a plan that

(i) outlines every bit of information associated with the evaluation study,
(ii) spells out details of all the operations to be carried out in the investigation,
(iii) provides information on all stages of evaluation including formulation of the problems, data collection and data analysis.

Alternatively, the research design in evaluation research may simply be:

(iv) a plan for collection of data.
(v) an outline for collection and analysis of evaluation information.

Depending on the paradigm of research chosen by the researcher, the scope of a conceptual framework may be as detailed as (iii) above, showing the methodological plan for the control of variables (especially in quantitative study based on the positivist tradition).

DESIGNING FRAMEWORKS FOR DIFFERENT TYPES OF STUDIES

The characteristics and steps in developing a design, to a large extent, are guided by whether the study adopts any of the following frameworks:

(i) Quantitative or qualitative research paradigm
(ii) Experimental, survey, ethnographic type of study

The choice of type of research determines the nature of variables and questions to be addressed; though it is also true that the definitions or meanings given to the key concepts of a study determine which paradigm or type of study to pursue. For instance, whereas learning may be conceptualized as students' achievement in one study, in another the researcher may be interested in the processes and/or quality of experiences the learner passed through. While the former (and many other concepts studied in educational research) lends itself to quantitative procedures and measurement – oriented data collection procedures, the latter may require more in-depth, process-oriented qualitative procedures.

Authors, comparing quantitative and qualitative research, indicate that quantitative researchers work with a few variables and many cases or subjects whereas qualitative researchers rely on a few cases and many variables. This implies that the contents and requirements for a research design for qualitative research is bound to differ from that of quantitative research. The format for designing a quantitative research is as follows:

- Presenting a research problem;
- Asking research questions;
- Collecting data to answer the questions;
- Analysing the data;
- Answering the questions.

A hallmark of good research design, especially in educational and social science research, is one, which ensures validity and reliability of measurements and results of the study. There are several unique features that differentiate the design of qualitative research from the traditional. A summary of the features of a qualitative research design includes:

- Presentation of the overall strategy including explicitly or implicitly stating the philosophical assumptions that guide the study (e.g. whether Ontological, Epistemological, Axiological, Rhetorical and Methodological);
- Explaining the specific setting, population and phenomenon;
- Explaining the sampling of people, behaviours, events, and/or processes;
- Highlighting issues of Entry, Reciprocity, Personal Biography, Ethics, etc.

PRINCIPLES OF DESIGNING AND DEVELOPING A CONCEPTUAL FRAMEWORK

A conceptual framework is an abstract and stylised ordering of research ideas, which is meant to guide the research design. For it to be effective and efficient, the following principles should be followed while designing and developing a conceptual work:

Principle of clear research premising and assumptions

The primary purpose of a conceptual work is to demonstrate familiarity with present intellectual currents and concerns. It is also to justify a research problem or questions and help determine the research design. The conceptual frame must quickly situate a research work within the context of field's theoretical themes. The researcher should clearly state what has been taken for granted or what the guesses are. For instance, if the main research idea is to know why boys perform better in Mathematics than girls do, and we want to focus our investigation on intelligence and motivational factors, then we have assumed that all other factors are equal.

Principle of clarity and precision

As with the methods used, a researcher must be prepared to tease out and concretise any concept he or she hopes to use since every discipline contains its neologisms and jargons that might not be clear to all readers. Researchers must design and develop a conceptual framework in such a way that readers fully and easily grasp the internal logic of the study. There should not be any ambiguity or insufficient information about affected concepts, constructs and variables as well as their relationships.

Principle of navigational change

Many times research questions change in the course of designing and executing a research owing to practical situations. It may be worth thinking about reformulating some questions in a way that would allow a researcher to provide effective answers. In this case, one may need to modify the conceptual framework to reflect the changes.

Principle of details

Researchers should put as much details into conceptual work as needed. Once you have your topic, you should identify areas that your conceptual work will cover. However, your conceptual work should not be a long list of concepts without details about each concept. Researchers should communicate through the conceptual framework, be it diagrammatic, graphic or mathe-matical in elegance.

STEPS IN DESIGNING AND DEVELOPING A CONCEPTUAL FRAMEWORK

(A) ***Getting a research idea or concept***

A *research idea* or *concept* may emanate from personal interest, personal experiences, experiences of others or relevant literature. For instance one may simply be wondering why girls perform better in English Language than boys do, perhaps after reading a research carried out by others. The idea or concept of "performance" in English Language comes in here. The first technical step in a social science investigation is to get a research idea or concept. Unlike the physical, chemical and biological sciences, social scientists study such abstract concepts as performance, intelligence and motivation. These concepts are not real in the physical sense; they are intangible, existing only in the mind (Marshall 1997). The next step is to design a conceptual framework beginning from construct formation.

(B) ***Sharpening a research idea through progressive focusing***

Progressive focusing follows getting a research idea. Having got the main research idea or concept, the researcher should familiarize himself or herself with the general knowledge in that area of interest. He should take good notes and analyse the notes to *impose an order* that is meaningful to readers.

(C) ***Formulating a research idea into a construct***

A construct is a special concept purposely designed to fit into theoretical schemes in which a concept (say performance) is deliberately adapted to enter into a structural outline specifying relationship between the research idea and other related concepts (such as "intelligence" and "motivation"). In this case, we may change performance to "academic performance" and therefore say that academic performance is a function of intelligence and motivation. This statement is a construct since "a construct is a statement, supported by evidence, that two concepts are related in some ways" (Marshall 1997). Apart from using a construct (a designed theoretical statement) to specify relationship that fits into a theoretical scheme, the researcher specifies the research idea or concept in such a way that he or she defines in a specific manner, each of the other concepts, which he or she relates to the main research idea. For instance, "intelligence" is so defined and specified that it can be observed and measured. We can make observations of the intelligence of children (boys and girls differently) by administering intelligence tests or we can ask teachers (of English Language) to tell us the relative degrees of intelligence of boys and girls in their classes (Kerlinger 1979).

(D) ***Transforming a research idea into variables***

A *variable* is a symbol (v or x) to which numerals are assigned, for example scores on an intelligence test. This set of values often called IQ's, ranges from low to high or from 50 to 150 (Kerlinger 1976). A variable may have only two values (dichotomous variables) like in the case of "sex" where x can take values 1 or 0 standing for one of the sexes. However, some other variables are polytomies. While it is not possible to convert a true dichotomous variable such as sex into a polytomy, it is always possible to convert a polytomy like intelligence to a dichotomy by breaking it down into high and low instead of high, medium and low.

(E) ***Transforming a research idea into operational variables***

The next step is to define each variable operationally by specifying the activities or processes or procedures needed by a researcher to measure each variable. For instance, "academic performance" may be measured by teacher-made test, or by achievement test, or by aptitude test. On the other hand, as in the case of an experiment, the researcher spells out the details of the investigator's manipulations of each variable. For instance, if students are to be "motivated" or not motivated, the investigators may introduce praises, punishments, money, promotion, and so on.

(F) ***Getting a research conceptualized into a model or conceptual framework***

Through progressive focusing, the researcher may get more than one constructs but each construct should be conceptualized into a model. A model is different from a theory in the sense that while a model is a verbal or diagrammatic representation of the way two or more concepts or ideas relate to each other, a theory requires two or more interrelated constructs or evidentiary statements. In a diagrammatic model, a researcher should represent concepts or research ideas as circles and lines of influence as double lines, single lines or broken lines depending on whether the influence is strong, moderate or weak.

Here's an example of how you could use shapes, lines and text to build a chart:

- The shapes (such as rectangles, circles or diamonds) represent each step or decision point in the process;
- The lines show the continuity of the process, demonstrating the paths the user should follow;
- The text briefly describes each part of the process. Follow along on this simple flow chart (Fig. 3.1).

Figure 3.1 portrays some of the long-term relationships between causes and symptoms of hunger. Poverty, including the associated vulnerability of natural or man-made shocks, is not a root cause of hunger. Yet poverty and its dynamics may be seen as an endogenous outcome of limited resources and flawed policies. Endogenous and exogenous relationships are conceptualized at different levels of analysis. The figure traces broad interactions between root causes such as policy failures

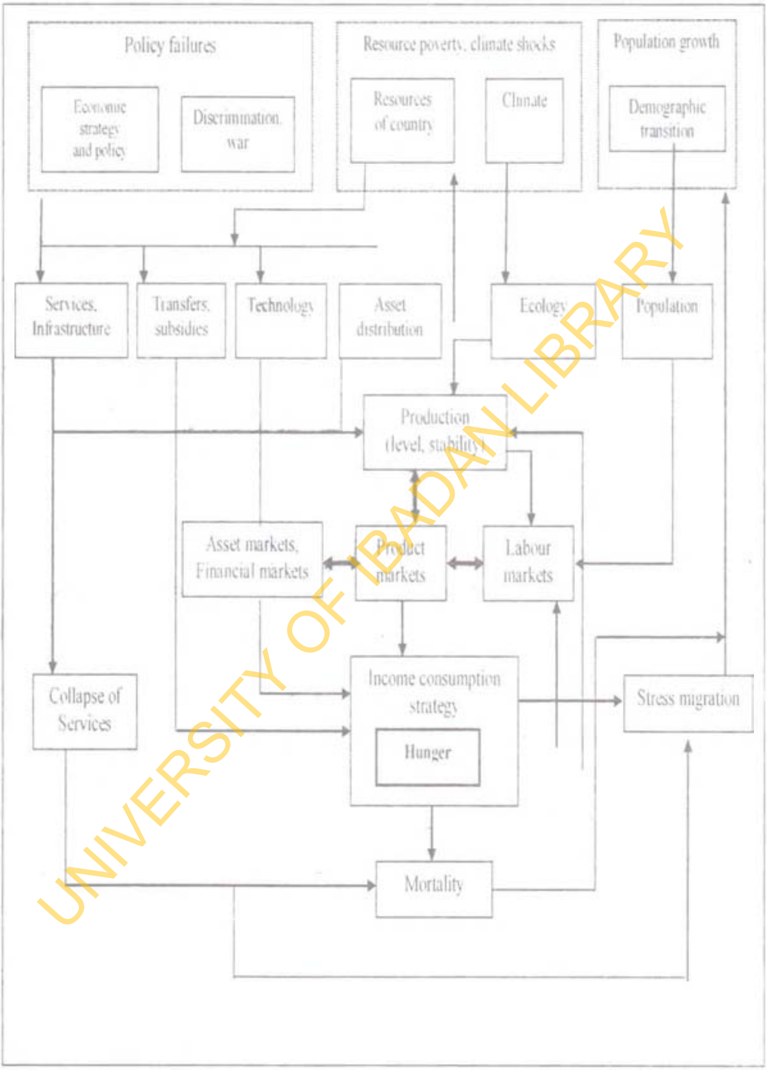

Fig. 3.1 A flowchart showing Relationships among variables responsible for hunger in developing countries.
(Adapted from T. Teklu, J. van Braun, and E. Zaki, 1991)

(including war) resource poverty and climatic disruptions and population growth and outcomes in the realm of macroeconomic activity and household strategies. For example, the top row of causal factors represents economic strategies and policy interacting with social discrimination, conflicts and military conflict, resource endowments and their relationship to climate or disasters influencing levels of poverty and food availability: and population growth. These elements directly affect both the design and the success of policy and project interventions such as subsidies and distributional policies that influence input/output relationships and thereby influence domestic food production levels and stability.

Other policies such as wage policy and project interventions, such as paid labour-intensive public works, interact at the level of capital labour and output markets. These relationships determine prices and hence the real purchasing power and terms of trade of the poor. Severe deterioration in or rapid fluctuations of purchasing power and terms of trade among the poor can have a strong impact on nutrition. It is in such instances that income and consumption failure become most severe and result in extreme hunger, and that the failure of household "entitlements" become evident.

Analytical discussion on any one of these interactions should be pursued with recognition of the upstream/downstream and short-term/long-term linkages between individual elements. Recognition of the complexity of these relationships is crucial for effective action aimed at curbing and eliminating hunger.

A researcher should differentiate between linear and nonlinear models by studying the form or graph of line of influence between two concepts. Fig. 2.2 shows a diagrammatic representation of the conceptual framework.

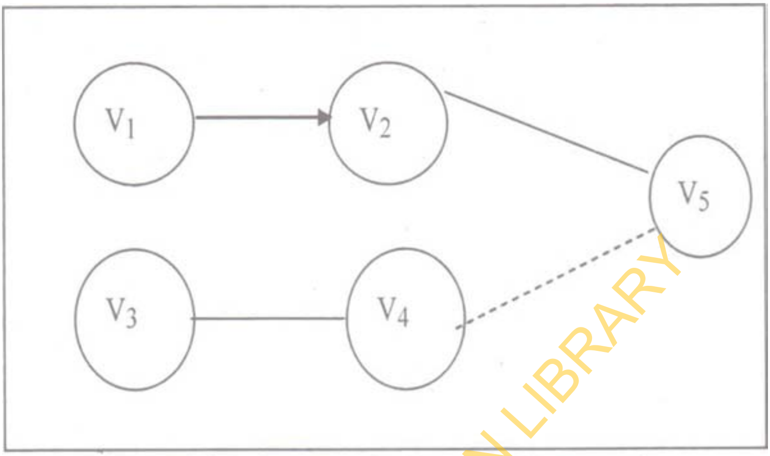

Fig. 2.2 A Diagrammatic Conceptual Framework

CRITERIA FOR EVALUATING A CONCEPTUAL FRAMEWORK

- **Effectiveness**: we should make sure that the conceptual framework solves the problem it was intended to solve or explains the anomalies which were perceived by the researcher.
- **Internal consistency**: we should ask whether the conceptual framework is internally consistent.
- **External consistency**: we should ask whether the conceptual framework is consistent with other accepted theories and thinking.
- **Evidentiary criterion**: we should confront our conceptual framework with known statements of fact and evidentiary or methodological demands. In this case, it might be necessary to know what data would be needed and from which sources.

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4

PREPARING A RESEARCH PROPOSAL

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INTRODUCTION

The primary objective in preparing a competitive grant proposal is to produce a proposal that will stand out from so many others that are submitted to funding agencies for funding. This will entail selecting an effective title, developing an effective summary, articulating the study objectives/hypotheses, writing a good introduction, choosing appropriate experimental design/methods, planning for expected/unexpected results and developing a realistic budget. In addition to the fact that funding agencies have their own interests, priorities and dictates, the standards of a good proposal constitute the dilemma of students and researchers who are faced with the task of proposing a study (Bamiro et. al. 2003).

From experience, it is important to note that the art and science of developing a proposal is not an easy task. But it is even more difficult to conduct a study without a proposal development preceding a research quest. The difficulty associated with the development of a proposal lies necessarily with neither the failure of lecturers instructing courses in research methods nor the inadequacy of available texts in the area of methodology. Instead the impediments hover around the inability of some researchers and students to piece together the various techniques and tools which have been learnt over a period of time. The problem is even worse among students who oftentimes conceive of every subject or course in terms of examinations and not internalising what is taught and how it would be applied later in life. Similarly, the variety of texts available hardly present the character of a proposal or have as a theme proposal writing such that the average reader at the end of the day is left to figure it out himself what a proposal is all about.

It is in the light of the preceding discussion or background that the examination of the various stages necessary for a successful proposal design becomes necessary. In doing this we would attempt to ground the discussion by making each level as empirical as possible by citing concrete examples and as well conceptualizing key terms on which each level hinges upon.

In an attempt to discuss the subject, it is important to begin from the premise of what a proposal means. What is a proposal? Or, put differently, what does a research proposal entail? Put simply, *a proposal is a statement or planning document of intent, which shows how a study would be executed* (Mouton and Marais 1996). In other words, you have to layout the details of your plans and as well as a sales document for someone else's review or approval. The approving body or person might be an instructor/lecturer, or a funding agency whose resources (time or money) you intend to spend (Babbie & Mouton 1998). As it is with every rational man or venture, resources have to be judiciously expended on projects that would meet the organization's goal and also benefit or reach the end user of the product. It is in this sense that supervisors or assessors are concerned with how their resources would be utilized and the extent to which the programme being proposed meet their need as well as benefit the end user of the outcome (findings).

It is, therefore, clearly of considerable importance that the proposal should convey a favourable impression of the project and illuminate the researcher's ability to handle the subject.

- Does he know the subject sufficiently well?
- Is the area of study relevant to the contemporary issues of interest or the target of the funding agency?
- Does the plan and use of time convey an impression of the researcher's competence and ability to execute the project successfully?

These, among other issues, determine the quality of the proposal. The next section will briefly model schematically the structure of a grant proposal. The third section of the chapter discusses the format for a thesis research proposal while the final section of the chapter outlines the success and failure indicators of proposals.

COMPETITIVE GRANT PROPOSAL
Project Overview

- *Title*: This should be a short phrase describing the subject of the proposal
- *Proponent*: Provide the name of the research organization, the name of the project leader, and collaborating research organizations.
- *Estimated budget*: Give an estimate of the total cost of the project in national currency. Indicate the current exchange rate of the local currency against the international currency, e.g. the US dollar, the Euro, or the British pound.
- *Estimated duration*: Indicate how many months it will take to complete the entire project, including writing and submitting the final reports.
- *Objectives*: Indicate both the general and specific objectives of the project.
- *Abstract*: Provide a summary of 150 to 300 words of the problem, how it will be studied, and how the findings will be used.

The maximum length of a proposal can be discussed with the Programme Officer. Generally, the total length of the research proposal, excluding appendices, should not exceed 20 single-spaced pages.

Components of Research Proposals
The components of a research proposal can be divided into two broad groups, namely:
- Core components
- Additional components

Core components of research proposals

The core components of a research proposal include the following:

- A description of the research question
- An indication of why the problem is relevant
- A review of relevant literature
- A description of the proposed methodology
- A time frame

In other words,

- What do you want to do?
- Why do you want to do it?
- Why is it important?
- Who has done similar work?
- How are you going to do it?
- How long will it take?

Make sure that these are meaningful and not mechanistic.

Additional components of research proposals

Depending on the project, additional components of a research proposal will include the following:

- A budget
- A description of how the research findings will be disseminated
- An outline of team members' responsibilities
- Capacity development
- Ethical statement
- Possible problems
- Other information required by funders.

Always try to find out exactly what the funder or organization expects in a proposal, and provide it in writing.

Choosing A Topic

Peil (1982) noted that confused thinking at the beginning of a research can cause flaws in all that follows. In some cases, lack of interest or time by the supervising body or person in case of academic research can exacerbate the confusion. The issue, therefore, is that once an individual has chosen a general area where a topic is not given, for example Human Immune Deficiency/Acquired Immune Deficiency Syndrome (HIV/-AIDS), the researcher must narrow down the topic to a set of specific questions which can be answered in a single study, for instance, "*Poverty and HIV/AIDS Patient Management in Swaziland: A Case Study of Known HIV/AIDS Patients*" (Owumi and Ezeogu 2003). From the general focus, the authors have been able to narrow the subject to "Poverty" and "Known Patient Management". This "zeroing down" came from a perusal of the literature. No subject is new in the same way as all initial conception of topics are also vague; thus, the desirability of literature search in order to sharpen and streamline the research focus. Even in situations where topics are allocated, the researcher has no choice but to seek relevant literature in the area for an adequate understanding of what the subject is all about. Simply, get acquainted with the subject. It also should be noted here that the aims of the study would begin to crystallize from this stage onward. This preliminary work in itself does not constitute an adequate literature review. Babbie and Mouton (1998) actually referred to this exercise as *preliminary scanning of literature*. It must be emphasized here that the currency/relevance of the topic and the supervisor's interest/bias are of tremendous importance in terms of the successful completion of the study at this stage.

Aspects of a Research Proposal

The research question

The first step in developing research proposals involves finding a research question. Researchers get their questions from many different places, including:

- Observation of the world
- Concern with theory
- Previous research
- Practical concerns
- Personal interest

The criteria for choosing a research question include the following:

- Access to information
- Access to resources
- Theoretical background
- Value of research
- Researcher's skills
- Is question big or small enough?
- External requirements
- Overall probability of successful completion
- Interest to researcher

In choosing a research question:

- Remember that a broad research area is NOT a research question
- Formulate a number of possible questions, and weigh up the pros and cons
- The proposal must reflect that the issues have been thought through.

Problem and Justification

Usually, this section of the study should be very concise and straight to the subject of interest. Since the proposal is a sales document as it were, emphasis should be on illuminating the subject and creating an understanding of the existing situation, as in the case of our Poverty and HIV/AIDS study referred to above. A brief background of HIV/AIDS and Poverty is inevitable. What is the relationship between these variables? What is the situation of the pandemic either globally or locally? What is the status of those afflicted? Gradually, as these questions are addressed, the persistence of the problems at stake would begin to emerge and how the gaps would be filled becomes manifest. The problems in our example of HIV/AIDS study is, high incidence, nature of management of the ailment and status of patients with the ailment, In an attempt to unravel the riddle surrounding the high incidence rate and especially among the poor in the society, you are filling an identified gap, which is the problem. The problem therefore leads you logically to the aims of the study, which is what you hope to achieve, as in our earlier example. The study attempts to find out the relationship between "Poverty" and "HIV/AIDS". It also attempts to examine the status of the identified patients and the sources of resources for their hospitalization and its impact on their welfare.

This section should normally make up between one quarter and one half of the proposal. It should describe the problem that is to be investigated and the questions that will guide the research process. Note that proper justification of the importance of the research questions to be addressed requires some sense of the likely contribution to knowledge that the research will make and its place in current debate or technological advance. Often, this can be presented in the form of research hypotheses to be tested. The section should provide a brief overview of the literature and research done in the field related to be problem and of the gaps that the proposed research is intended to fill.

To show the importance of the problem, this section may discuss such points as:

- How the research relates to the development priorities of the country or countries concerned;
- The scientific importance of the problem;
- The magnitude of the problem and how the research results will contribute to its solution;
- The special importance of the project for vulnerable social groups; and
- The need to build up research capacity in the proposed area of research.

Proposals should be explicit about the capacity building needs that the project will address. If the proposal is for the second phase of a project or if the applicant has received funding in the past for similar work, describe the results of the previous work and indicate why additional work is required.

Objectives

The objectives section of a proposal is typically very brief, usually a half page at most. This is because the rationale for each objective will already have been established in the previous section, while the ways of achieving the objectives should be explained in the methodology section.

The general objectives provide a short statement of the development goal being pursued by the research.

The specific objectives are operational in nature. They may indicate specific types of knowledge to be produced, certain audiences or publics to be reached, and certain forms of capacity to be reinforced. These are the objectives against which the success of the project will be judged. It is important to distinguish the specific objectives from the means of achieving them, such as pursuing fieldwork, organizing a network or a workshop, or publishing a book.

Hypothesis

It should be stated clearly here that hypotheses are not a must in all studies but where the data generated is large and statistical in nature, hypotheses become inevitable. An hypothesis is the unexpected but unconfirmed relationship between two or more variables (Singleton & Straits 1999). It is actually a proposition that posits a relationship between one observation or variable and another. For example, "Poor people are more likely to die earlier from HIV/AIDS than rich people". Hypotheses are usually not statements of belief; instead, they should state a relationship that is precise and easily observable or measurable.

Literature Review

As already noted earlier, literature review actually commences as soon as a topic is conceived. The rationale for this is clear as noted earlier. At this current stage of the study, the need for detailed review of relevant material on the subject is paramount for the researcher to know what other scholars have done and how or where they were done or executed. It would also assist the researcher to know how, if any, the current study would be different from earlier ones. It must be pointed out however, that a literature review is meant to facilitate a critical analysis of the data emanating from the study. Information of other or earlier researchers is necessary to buttress or jettison the data from the field. In this way, the reviewed works benefits the research conducted.

Similarly, an appropriate and relevant theory to guide the study is inevitable. Put differently and in simple terms, no one builds a house without a plan. This is essentially the role a theory plays in research. It directs or patterns the trend of discussion and thus makes our argument non-amorphous. What is expected of the researcher is to identify a relevant and appropriate theory and discuss in details the theme and how it would be applied in the study. This also helps in the selection of the research method to be adopted in the course of the research.

Purposes of Literature Review A review of the literature serves the following purposes:

- Provides a conceptual framework for the research;
- Provides an integrated overview of the field of study;
- Helps establish a need for the research;
- May help clarify the research problem;
- Helps to demonstrate the researcher's familiarity with the area under consideration (theory and/or methods).

Skills Involved in Producing a Literature Review

A good literature review generally contains an argument: its production entails:

- Surveying a comprehensive range of existing material and sources in the general areas of your study;
- Selecting those that will be most relevant and significant for your particular project;
- Understanding and analysing the central findings and arguments;
- Synthesizing the findings and integrating them into the research proposal.

Sometimes the literature review includes progress on what has been known/done on the research topic from the time interest started to the present time. For example, gender issues became topical in the 1970s but interest has greatly expanded what was known then to present time.

How to Write a Literature Review

In writing a literature review:

- Indicate the ways in which the authors you are reviewing will be relevant to your research (information; theory; methodology). Undertake an unbiased citation of papers with contrary views
- Demonstrate that you understand the similarities between these works and paradigms. Where do they stand in relation to each other? Where does your research stand in relation to them?
- The works that you refer to should reflect recent scholarship as well as those considered of seminal importance. If possible, cite papers less than 10 years old
- If the study is cross-disciplinary or comparative, you need to describe how the different areas of research can be drawn together in a meaningful way.
- Cite your previous work but show moderation.
- Cite only papers you have actually read.
- Seldomly cite unpublished, non-peer reviewed material.

The following questions will help you in compiling a literature review:

- What are the broad bodies of literature that have relevance for your research topic (local and international)?
- What theoretical model(s) relate to your research topic?
- What theories, methods and results have previous researchers in your field produced? What is the history of your area of study?
- What are the most recent findings in your area of study?
- What gaps or contradictions exist among these findings?

- What new research questions do these findings sug-gest?
- What structure suits my literature review best?
- What should I leave out?

The literature review is NOT:

- Part of the research project. Although there may be an ongoing review of literature throughout the project, funders expect a solid preliminary review to have been carried out before a proposal is submitted.
- A bibliography.
- A series of descriptions of pieces of previous research with no apparent connection to each other or your project.

Methodology

The proposed research may be exploratory or highly structured, quantitative or qualitative. However, the methodology section should begin, in all cases, by defining the conceptual framework and theoretical frame of reference that will guide the research. The main explanatory and dependent variables should be identified and related one to another. What does the methodology section do?

- The methodology section shows the reader how you are going to set about looking for answers to the research question (including, if appropriate, materials and methods to be used).
- It must include enough detail to demonstrate that you are competent and the project is feasible.
- The proposed methods must be appropriate to the type of research.

The methodology should consist of the following:

- Hypothesis
- Research design
- Sampling
- Measurement instruments
- Data collection procedure
- Data analysis

Method of Data Collection

Proposals should indicate what approaches and methods will be used to collect primary and secondary data and information. Provide details on available sources of secondary data or the methods to be used for the collection of primary data, such as questionnaires and group discussions. Outline the procedures for the development, pre-testing and administering of any research instruments.

If survey work is involved, give detailed information on the study area. If the research is related to human populations, information on the study population should also be provided. Include a description of the procedures for selecting the population sample and the sample size. The survey sample should reflect ethical considerations to protect confidentiality and gender balance, in appropriate cases, among surveyors or those surveyed.

If biological samples are to be collected, provide information on the number and type of samples, the method of collection, who will perform the collection, and how the samples will be transported, stored and analysed.

If laboratory procedures are involved, standardized procedures and protocols must be stipulated (quote relevant references). Describe new or unique procedures in detail and specify the quality assurance procedures that will be followed.

In the social sciences, there are a variety of methods of data collection open to the researcher to choose from. The choice of method is influenced by a number of factors including the choice of topic, respondents, and the type of study (be it exploratory, descriptive, explanatory or experimental). Whatever choice we make, we must bear in mind whether the method would answer the questions set out earlier. Is it in agreement with the theory? Will different methods be required for robust data to be gathered? If yes, then *Triangulation* is recommended. Triangulation is encouraged because no singular method may furnish the researcher with the required data (Frankfort-Nachmias & Nachmas 1996). In the Poverty-HIV/AIDS study referred to above, Structured Interview and observation methods were adopted. Efforts should be made to detail fully the sample size and how samples would be chosen in case of survey, in the same way as when informants are required for structured interview.

It is best to organize the methodology to explain how each specific objective will be achieved. The proposal should provide enough detail to enable an independent scientific assessment of the proposal. Assuming that the research questions and research hypotheses to be addressed by the project have been clearly identified in the "problem and justification" section, the purpose of the methodology section is to show how these questions will be answered in the most rigorous way possible.

The methodology section deserves greater emphasis than applicants typically give to it. Proposals need to be clear about what activities are envisaged in pursuit of each objective, and this must be done before funding is approved. Indeed, it is impossible to define the budgetary needs of the project in the absence of a solid methodology section.

Data Analysis

The data from the field is useless if not analysed. Here, the researcher must state whether the data would be analysed qualitatively or quantitatively. In making this choice, the researcher must take into cognizance the methods used in the data collection process and the size of the data to be analysed. Once these facts have been taken into consideration, a reliable result is envisaged at the end of the study.

Finally, describe what types of data analysis or modelling exercises will be carried out. Describe the procedures for processing and analysing the data, including the project's needs for computer facilities.

Gender Considerations

State whether gender considerations constitute an important dimension of the project in defining the important relationships of the problem or in data collection and show explicitly how the methodology will address them.

Ethical Considerations

Projects that involve research on human subjects, the collection of private or personal information, or the participation of individuals in experiments must be designed in ways that protect the privacy, dignity and integrity of those who are the subjects of research.

For projects involving research on human subjects which raise ethical issues, funding agencies often require that an independent ethical review committee, whether in the recipient institution or in the host country, must approve ethical protocols. This applies most often in health research. In such a case, please attach a document certifying that ethical approval has been given. The proposal should also provide detailed information on the ethical dimensions of the research and how these are being handled.

For projects involving the collection of corporate or personal information, the proposal should provide details on how informed consent will be obtained and how the information will be depot confidential.

For projects that involve participating in an experiment (such as farmers testing a new farming practice or community members responding to group questioning), provide information on the free consent of participants and how it will be obtained. Outline how research findings will be reported back to the people concerned.

Training

Identify how the project might contribute to the training of staff and whether it would be necessary for certain staff to undergo training prior to or during the project. What kinds of training would be most appropriate (e.g. formal graduate training, non-formal skills upgrading course, visits or missions, etc.), and how will it be organised?

Organizational matters

For larger projects, or networked initiatives, organizational elements are an essential part of the methodology, and may constitute an important part of the methodology section.

Collaborative arrangements with other country-based institutions

In the case of collaborative projects with institutions based in other countries, provide the reasons for the collaboration with the scholars. How will the cooperation between researchers from different locations be organized? What will be the division of labour?

Time Frame
Be realistic. Inexperienced researchers tend to underestimate how long the stages of research will take.

Budget
The primary reason for submitting a grant to a funding agency is to secure funding. The investigator should, therefore,

- include a detailed budget breakdown if required;
- follow the requirements of the organization to which you are submitting the proposal.

Indicate the time needed to carry out each phase of the project, as well as the project's total duration. Remember to take into account the time required for staff recruitment and equipment purchases. Indicate possible constraints in adhering to the timetable. Estimate the project's total costs, indicating the yearly contributions to be made by each institution or agency involved. Allow for inflation and indicate the level of inflation used in the estimate. All budget items must be quoted in national currencies.

The budget should be divided into two categories, the funder's contribution and the local (recipient) contribution. The local contribution can be an estimate of "in kind" resources such as salaries, equipment etc. The budget estimates should be computed on an annual basis.

In any given study, finance is a major component, although this is not often stressed in academic research for students pursuing a course of study. Of necessity, there is the need to state how much would be needed to complete the study, how it would be spent at every stage of the study, how long it would take to complete the study, and what would be done at every stage should also be clearly stated.

References

It should be noted and emphasized that the list of consulted/relevant texts must be included at the end of the proposal. This aspect of the proposal gives the assessor an impression of how familiar the researcher is with the subject. References indicate the works cited in the body of the proposal while Bibliography refers to all relevant texts/materials to the subject of investigation but not all cited in the body of the proposal.

Significance of the research

The research must be of value. This may include:

- Practical value in solving problems;
- Value to policy development;
- Contribution to theory;
- Contribution to body of knowledge within discipline;
- Funders often specify the nature of "value" they are looking for in research.

Report Writing and Outlet

DISSEMINATION OF FINDINGS

If funders want to support a valuable research, they also want to see that the research results will be disseminated. If research is intended to assist a community, it is of little use to publish it only as an internal research report. Usually, the study is meaningless if the final product is not written. The analysed data must be presented in writing to show whether the money spent has been well expended or to indicate what contribution has been made to knowledge. In doing this, caution must be taken in the design of the structure, and the targeted audience for the adoption of suitable medium of communication.

Similarly, how the outcome of the study would be disseminated is also of importance to the quality of the proposal, especially in studies that are funded by some agencies. Findings could be disseminated through posters, symposia, seminars, to mention a few. Begin by defining the major outputs expected from the projects, while outlining plans for disseminating or implementing the findings of the proposed research. Examples of outputs include workshops and conferences, reports and publications, new methodologies or technologies, improved research skills, and institutional reinforcement. Show how research results will be communicated to users and decision-makers.

Discuss how research results are likely to be used. Identify the immediate or intermediate users of the results and show how they will be given access to the research results. Who will ultimately benefit if the project results are appropriately used?

The expected impact of research results can be discussed in reference to some or all of the following:

- Their potential use in other settings;
- Their contribution to existing technical and scientific knowledge;
- Policy formulation and implementation;
- Development processes at the local, national and regional levels; and
- The needs of specific target populations.

Discuss any possible obstacles to the execution of the research and to the eventual use of the results. These may include possibilities of political or economic instability, expected difficulties in securing access to data, the difficulty of coming to categorical conclusions, and the partial nature of the results for addressing specific development problems.

Intellectual Property

Research inevitably leads to the creation of intellectual property. Quite often, the funder's policy may be that written materials and documentation are owned by their creator, who also holds copyright. However, the funder may seek the right to disseminate the information so that the benefits of the research will be circulated as widely as possible. If a technology is developed during a project, funder's main objective may be to ensure its dissemination and utilization. Where relevant, the recipient will be asked to sign a Memorandum of Understanding which sets out the ownership and royalty regimes that will govern the project. Typically, the funder's role is to help secure appropriate protection for intellectual property rights internationally, with the recipient having full licensing rights in all countries. Apart from recouping any costs of patenting, the funder will receive a share of any profit only in those cases where significant revenues may be generated. It could be the funder's policy to recoup any grant given to a private sector company if the technology it develops is successful.

Institutions and Personnel

Institutions

Briefly describe the research institution, including its history and objectives. Similarly, provide information on collaborating agencies and those institutions or agencies that have been involved in planning the research, that will be involved in carrying it out, and that will be asked for funds. Highlight the particular strengths or past achievements of the institution.

Describe previous or on-going support to the person, unit or institution in the field of research related to the proposal. How might the proposed research complement the institution's existing programme?

Personnel

List the personnel who will be involved in carrying out the project, their roles and their time commitments. Describe their qualifications, experience or any other relevant information. Include the resumes of the principal professional staff.

User Participation

The participatory aspects of the project are often important. Indicate whether the ultimate users of the research results were involved in the design of the project and what role they will play in executing the project or in implementing the results.

Evaluation

Certain projects benefit from more extensive evaluation than that corresponding to normal management and monitoring. Such cases include projects that are particularly innovative or risky, those from which significant lessons can be learned, and those that require a very high level of accountability. Indicate if the project will include an explicit evaluation component. A description of the evaluation component should

- identify who will use the evaluation findings and for what purpose(s),
- focus on a few specific issues that are well defined and relate directly to the project's objectives and activities,
- specify the methods by which data will be collected, and
- identify the resources necessary for the evaluation.

THESIS RESEARCH PROPOSAL

A thesis research proposal is a proposal submitted to an academic institution for the purpose of a higher degree. It is expected to show your examiners that you can do good research for your thesis. It must be a well-written document (like an extended paper or a thesis) containing a thorough study of your research topic.

The principal aim of this type of proposal is to provide information about the intended research project in terms of content and methodology so that a Department, Institute or Faculty could assess

- the feasibility of the project,
- the suitability of the candidate being registered for a research degree (Master or Doctorate), and
- who is the most suitable member of the academic staff to serve as supervisor to the candidate.

The proposal should normally be developed in consultation with a member of staff, and should not exceed 5000 words. It is generally understood that the student may need to deviate from the proposed outline as the actual research degree unfolds.

The features of a thesis proposal bear similarities to those of the final dissertation/thesis (Olayinka et. al. 2004) and a paper in a learned journal. These will be highlighted in Chapter 11 of this book. *A good proposal should provide the outline of the first three chapters of the dissertation/thesis.* It should begin with a statement of the problem/background information (typically Chapter 1 of the dissertation/thesis), then move on to a review of the literature (Chapter 2), and conclude with a defining of the research methodology (Chapter 3). Obviously, it should be written in a future tense since it is a proposal. To turn a good proposal into the first three chapters of the dissertation/ thesis consists of changing the tense from future tense to past tense (from "This is what I would like to do" to "This is what I did") and making any changes based on the way you actually carried out the research when compared to how you initially proposed to do it. Often the intentions we state in our proposal turn out differently in reality and we then have to make appropriate editorial changes to move it from proposal to dissertation.

When should the Proposal be Written?

To answer the question of when the proposal should be written, the following points have to be considered:

- A research proposal (particularly at the postgraduate level) is an interactive process.
- A substantial amount of work has to be done before a proposal can be written.
- Some institutions assume that a research proposal will be written over six or even nine months.
- Seek advice on your draft from supervisors and peers.

Format for Preparing a Research Proposal for an MSc/Phd Thesis

The proposal would normally include the following components, depending on the nature of the project:

(A) *Topic and problematic*

The research topic formulates a problem that is worthy of research. The topic should

- be stated clearly and succinctly in one or two sentences;
- be determined after consultation with potential supervisors.

The topic is usually framed as a "problem" or question in need of an answer. The topic statement will invite your reader to ask why it is significant and "worth doing". A good research proposal identifies in the research topic a "problematic" to be investigated. Your statement of this will result from discussion of your area of interest with potential supervisors, mentors and others.

Framing the question is not always easy, and you need to ask yourself whether your proposed "problem" or "research question" is really the question to be asked and answered. The framing of the problematic is crucial in setting up the research, though it is common for researchers to revise and reformulate this as the research progresses.

- What is the relevance of and the rationale for choosing this area of enquiry?
- Why is the research question posed in the way it is?
- Does the candidate have any particular motivation for posing this question or does he/she possess any expertise in this area?

(B) *Background and context*

Your research topic needs to be located in its context and background. In sketching this background, you need to show how and why the topic came to be important and why it is worth researching. This means:

- Contextualising the research problem – how does it arise?
- Outlining its significance – what will be the outcomes, and for whom?
- Referring to key issues that are associated with the topic.

Background can be provided in several ways. Your theoretical interests or concerns may have generated the research, and its justification is to be found in a theoretical development or related literature. Where professional practice is the focus, you may want to describe and analyse the context of policy or organisational changes.

In any case, you should summarize the influences which come into play to shape your research. The analysis should lead you to interrogate your own assumptions about why the problem is significant. You need to ask what interests are driving the research and from whose point of view the problem is "significant".

(C) *Conceptual framework and related literature*

A conceptual framework, as described in Chapter 2, elaborates the research problematic in relation to relevant literature. This should include a brief critical review of the literature relevant to the research question. What are the main texts and trends informing the thinking which has led to the formation of this research question? It should deal with such matters as

- existing research and its relevance for your topic
- relevant theoretical perspective(s)
- key ideas or constructs in your approach
- possible lines of inquiry you might pursue.

Your proposal needs to show how the proposed research relates to a body of related studies, or literature. The orthodox way to do this is to write a brief version of the literature review on a traditional science model. This is not always possible, especially if there is little related past research. Another is to outline the kinds of theoretical sources that will inform your research – the available research perspective.

Though not all proposals need to include an elaborate conceptual framework, a well-developed proposal will do so.

(D) *Research design and methodology*

- How are the main hypotheses going to be investigated or researched?
- An outline of the methodology, research design and procedure should be given.

This section typically might

- refer to an accepted method or approach;
- highlight problems in developing a suitable approach (methodological issues);
- describe how data will be generated, analysed and reported.

(E) *Pilot and ethical issues*
In proposals for empirical research, details will need to be provided of the proposed pilot work, the sequence of the various investigations and the research instruments which are intended to be used. In addition, the relevant methods of analysing the data will need to be discussed. Candidates whose researches involve human-subject research should bear in mind that approval by an ethics research committee will be required before any collection of data.

(F) ***Research plan and timeline***
An outline of the approximate timetable of the various stages of the proposed research, from conception to completion, should be given. Your plan should specify what tasks you will complete at each stage – literature review, research framework, description of method, writing up of findings and conclusions and so on. These tasks should specify what writing tasks will be accomplished and when. It is helpful to:

- Map out the research as a semester by semester timeline;
- State semester writing objectives for each semester;
- State other outcomes at every given stage, such as seminars or conference papers;
- Allow a semester for revising the thesis.

You do not have an indefinite amount of time and other resources to complete the degree. Plan to complete in the minimum time, and plan how you will achieve this.

Thesis preparation is a challenging writing task. It will be helpful for you to specify what writing outcomes there will be at each stage. Students are encouraged to understand their research in terms of scholarly writing, whether or not field research is involved. Early completion is more likely if the thesis develops through specific writing commitments including short papers which may be presented at seminars and conferences.

Table 4.1 illustrates how a research degree thesis might be planned over six semesters

Time	Research stage	Writing/Report
Semester 1	• Proposal developed	• Proposal • Paper on the thesis argument • Thesis outline
Semester 2	• Reading of literature • Negotiate access field	• Short papers on: • rationale and conceptual framework • review of literature
Semester 3	• Field research: develop and pilot procedures • Database development	• Draft methodology chapter • Trial write-up of • selected material. • Rework conceptual chapter
Semester 4	• Field research • Finalize procedures and complete	• Short papers on field research • Write up research procedures
Semester 5	• Analysis	• Draft analysis chapter • Prepare conference paper
Semester 6	• Revision of thesis	• Draft conclusions • Final chapter • Revise and refine thesis structure • Seminar on conference paper
Semester 7	• Submission and examination	Final revisions Journal article

The research proposal which is submitted with an application is used primarily for making a decision about admission. It is not expected that this will be definitive or final. After commencing a research degree, it is normal for a research proposal to be modified as a result of further study and investigation, sometimes in substantial ways.

Evaluation of thesis research proposal

Those who will evaluate a thesis research proposal include the following:

- Higher degree committees
- Review panels
- Individual reviewers
- Specialists
- Generalists
- A mixture of experts in the field and reviewers from cognate disciplines

Evaluation criteria

The essence of a successful research proposal is the idea underlying it. How can we evaluate whether our idea is a good idea, the definition of a good idea being one with the potential to be funded? Our scientific idea must be important, that is, it must address a significant, non-trivial problem. The idea must be conceptually sound and doable, that is, capable of being investigated rigorously by the investigator using the resources available at his/her institution (see table 4.2).

Table 4.2 Evaluation Criteria

No	Criteria	Expectation
1	Significance	Does the study address an important problem?
2	Approach	Are the design and methods appropriate to address the aims?
3	Innovation	Does the project employ novel concepts, approaches, or methods?
4	Investigator	Is the investigator appropriately trained to carry out the study?
5	Environment	Will the scientific environment contribute to the probability of success?

Your major supervisor and co-supervisors are your allies. When you go to them for reactions to your proposal, make sure your major supervisor is fully supportive of you. Spend time with him/her before the meeting so that your plans are clear and you know you have full support. The proposal meeting should be seen as an opportunity for you and your major supervisor to seek the advice of the committee. Don't ever go into the proposal meeting with the feeling that it is you against them.

Provide the committee members with a well-written proposal well in advance of the meeting. Make sure they have ample time to read the proposal.

Plan the proposal meeting well. Graphic presentations of maps and other illustrations are likely to be necessary to help the committee with understandings so make sure you prepare them so they look good. You can also scan some of the diagrams and prepare for a PowerPoint presentation using multimedia facilities. A well planned meeting will help your committee understand that you are prepared to move forward with a well-planned research. Your presentation style at the meeting should not belittle your committee members (make it sound like you know they have read your proposal) but you should not assume too much (go through each of the details with an assumption that may be one of the members skipped that section).

Points to note in preparing a thesis proposal

- Don't be too quick to run away from using a quantitative methodology because you fear the use of statistics. A qualitative approach to research can yield new and exciting results, but it should not be undertaken because of a fear of quantitative research. A well designed quantitative research study can often be accomplished in very clear and direct ways. A similar study of a qualitative nature usually requires considerably more time and a tremendous burden to create new paths for analysis where previously no path had existed.
- Sometimes a combined methodology makes the most

sense. You can combine a qualitative preliminary study with a quantitative main study to yield a research project that works well.

- You may have the opportunity for conducting your research in conjunction with another agency or project that is working in related areas. Should you do it? Sometimes this works well, but most often the thesis researcher gives up valuable freedom to conduct the research project in conjunction with something else. Make sure the trade-offs are in your favour. It can be disastrous to have other project suddenly get off on schedule and to find your own research project temporarily delayed. Or, you had tripled the size of your sample since the agency was willing to pay the cost of fieldwork. They paid for the fieldwork but they are now unwilling to pay for the analyses. What happens to your research? You have to think twice before altering your project to accommodate someone else. Enjoy the power and the freedom to make your own decisions (and mistakes) – this is the way we learn.
- Keep back-up copies of your draft proposals.
- Remember the importance of good writing style- not only substance but also good use of English, task of typographical errors, etc- will improve evaluation.
- Theme should be some personal interest in topic- personal commitment is transparent.

SUCCESS AND FAILURE INDICATORS FOR PROPOSALS

The success indicators in a research proposal include the following:

- Clearly defined research question;
- Appropriate literature which provides a background to the problem;
- Use of other sources to identify/support the problem
- Objectives clearly specified;
- Conceptual framework and theoretical assumptions clearly stated;
- Appropriate design and methodology;

- Promotes further research;
- Preliminary data/pilot study;
- Necessary resources available.

On the other hand, the following can be identified as failure indicators:

- Too long
- Poor structure, language use
- Inappropriate use of technical terms
- Research too ambitious
- No literature review
- No integration of theory in literature review
- Literature review copied
- No theoretical foundation
- Budget not linked to methodology
- Unrealistic costing
- Methods not clear
- Methods inappropriate
- No references or bibliography

In concluding, it should be noted that there is no rigid chronological scheme in the development of a proposal, in the same way as there are no clues to perfect procedures to a successful proposal. This is due to the fact that the tenets and the hallmark of a good proposal are dynamic and institutionally determined.

The bias in this chapter has been on research-oriented proposals. However, it should be pointed out that proposals for funding can be a mixture of research, capacity-building, awareness raising, technology development and/or advocacy. At times, research in such a proposal might just be a means to an end, rather than an end itself. In other words, a research study in a funded proposal might only serve the purpose of providing information for planning an effective intervention or provide a database for future evaluation of the project's impact.

FURTHER READING

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5

USE OF LOGICAL FRAMEWORK APPROACH (LFA) IN RESEARCH PROPOSAL WRITING FOR GRANTS

B.O. Agbeja

INTRODUCTION

A lot of researchers in different disciplines submit proposals to various funding agencies (DONORS) worldwide for grants and fellowships. However, the grants being won every year are limited and only a few researchers that meet the requirements of these donors eventually receive the grants. It is well understood that for a prospective competitor to win grants, he or she should be consistent with correct reasoning i.e. skilled in logical argument of his/her proposal. Having discovered the failure of many competitors for limited grants every year, a scholar, an exponent of education named Dr. Peter Wood came up in 2001 in Kenya with a Training Courses Handbook on The Logical Framework Approach (LFA) to assist researchers and African Academy of Science (AAS) grantees in writing proposals that will virtually meet the requirements of funding agencies. As one of the African Academy of Science grantees that attended AAS and ISRA/CNRF CBFR Third Workshop Training and Symposium, Insitut Senegalais De Recherches Agricoles, CENTRE NATIONAL DE RECHERCHES FORESTIE-RES, Dakar, Senegal in December, 2001, I learnt a lot from LFA. I would therefore, like to share the same experience of LFA theory that I derived in Kenya with postgraduate students, mid-career lecturers and senior lecturers of this University so that when they are planning to write proposals for their postgraduate programmes i.e. postgraduate students (M.Sc; MPhil; Ph.D, M.A, etc.) and lecturers interested in individual and collaborative researches for grants under different funding agencies, the LFA theory could be useful.

THE LOGICAL FRAMEWORK APPROACH (LFA)

The Logical Framework Approach (LFA) is the main tool used for project design during the Identification and Formulation phases of the project cycle (Wood, 2001). Using the LFA during Identification helps to ensure that the project ideas are relevant, while during Formulation it helps to ensure feasibility and sustainability.

Two-Phase-Approach in LFA

- Phase 1: the Analysis Phase during which the existing situation is analysed to develop a vision of the 'future desired situation' and to select the strategies that will be applied to achieve it.
- Phase 2: the Planning Phase during which the project idea will be developed in operational detail.

The Analysis Phase

Projects are designed to address the problems faced by beneficiaries. A properly planned project addressing the real needs of the beneficiaries cannot be achieved without an analysis of the existing situation. However, the existing situation is likely to be perceived in different ways by different groups of stakeholders. Thus it is important to bring together representatives of all key stakeholders in the analysis phase. There are three stages to the analysis phase: problem analysis; analysis of objectives; strategy analysis.

Problem Analysis. problem analysis identifies the negative aspects of an existing situation and establishes the 'cause and effect' relationships between the problems that exist. It involves three steps:

i. Identification of the stakeholders affected by the proposed project
ii. Identification of the major problems faced by beneficiaries

iii. Development of a problem to establish causes and effects

Analyses of Objectives. While problem analysis presents the negative aspects of an existing situation, analysis of objectives presents the positive aspects of a desired future situation. This involves the reformulation of problems into objectives.

Example: Transforming Problems into objectives, i.e Problem ? Objective

- Hyper inflation and instability ? inflation and instability.
- High incidence of corruption ? Reduced incidence of corruption.

The objective can therefore be conceptualized as the positive mirror image of the problem, and the 'cause and effect' relationships become 'means to end' relationships. However, objectives dealing with a similar topic can be grouped together in clusters, which will provide the basis for Strategy Analysis. Once complete, the objective provides a comprehensive picture of the future desired situation.

Strategy Analysis. The final stage of the analysis phase involves the selection of the strategy(ies) which will be used to achieve the desired objectives. Strategy analysis involves deciding what objectives will be included IN the project, and what objectives will remain OUT, and what the project purpose and overall objectives will be. In addition to examining the logic, strategy analysis also looks at the feasibility of different interventions.

The Planning Phase

The main output of the LFA is the logframe matrix. The logframe sets out the intervention logic of the project (if activities are undertaken, then results will be achieved, then project purpose, etc.) and describes the important assumptions and risks that underlie this logic. This provides the basis for checking the feasibility of the project. For management and supervision of projects, the logframe defines the tasks to be undertaken, the resources required, and the responsibilities of management. In the second and third columns (objectively verifiable indicators, and sources of verification), the logframe provides the framework against which progress will be monitored and evaluated.

The Logframe Matrix

The logframe is the main output of the LFA. Before describing the logframe in detail, however, it is worth making a cautionary note. The logframe, for all its advantages when clearly understood and professionally applied, provides no magic solution to identifying or designing good projects. When used properly the logframe helps to make the logical relationships between activities, results, purpose and objectives more transparent, at least to the informed user. The logframe should be seen as an aid to thinking. The logframe must also be seen as a dynamic tool, which should be re-assessed and revised as the project itself develops and circumstances change. It should be used to provide structure and purpose to project planning and budgeting without being perceived as an inflexible and constraining blueprint. By bringing stakeholders together during the analysis phase, to discuss problems, objectives and strategies, the LFA encourages people to consider what their own expectations are, and how these might be achieved. By stating objectives clearly and setting them out in a 'hierarchy of objectives', it then provides a means of checking the internal logic of the project plan, ensuring that activities, results and objectives are linked. Planners are forced to identify the critical assumptions and risks that may affect project feasibility and to specify the indicators and sources of information that will be used to monitor and evaluate the project.

While the LFA has proven to be a useful planning and management tool, it is not a comprehensive tool and does not guarantee project success. The process is time-consuming and requires considerable training in the concepts and logic of the approach. The logframe itself consist of a table, or matrix, which has four columns and (in its most basic form) four rows (Table 5.1). The vertical logic identifies what the project intends to do, clarifies the causal relationships and specifies the important assumptions and uncertainties beyond the project manager's control. The horizontal logic relates to the measurement of the effects of, and resources used by the project through the specification of key indicators of measurement, and the means by which the measurement will be verified.

Table 5.1 Example of Logical Framework Matrix

4x4	Intervention Logic /Project Narrative	Objectively Verifiable Indicators	Sources/ Means of Verification	Assumptions/ Risks
Goal/ Overall Objective				
Purpose Results/				
Expected Outputs Activities				

N.B. *The sixteen boxes are the missing gaps/missing linkages that researchers need to fill in order to make relationships between activities, results, purpose and goal in the columns and rows.*

Levels of Objectives

The objectives selected for inclusion in the project are transposed into the first column of the logframe, and set out the intervention logic of the project. During this stage it is important to ensure that the levels of objectives are correct.

Vertical Arrangement (Column)

1. *Overall Objective/Goal*

The goal of the programme should explain why the programme is important to society, in terms of the longer-term benefits to beneficiaries and the wider benefits to other groups. It should also show that the programme fits into the regional/sectoral policies of regional government/organizations concerned.

2. *Project Purpose*
The purpose should address the core problem, and be defined in terms of the benefits to be received by the project beneficiaries or target group as a result of utilizing the services provided by the programme. To achieve a particular goal, there is only one project purpose!

3. *Results*
The results describe the services to be delivered to the intended beneficiaries or target group, and it should be possible for project management to be held accountable for the delivery. The results should address the main causes of the problems the target group faces. To ensure relevance of results, the problem analysis should therefore have identified a beneficiary demand for project services.

4. *Activities*
The activities show how the project's goods and services will be delivered. One of the keys to using the logframe successfully is understanding what the definitions mean in operational terms, and in particular the relationship between Results and Project Purpose.

Horizontal Arrangement (Row)
1. *Objectively Verifiable Indicators (OVIs)*
Objectively Verifiable Indicators describe the project's objectives in operationally measurable terms, and provide the basis for performance measurement. The specification of OVIs acts as a check on the viability of objectives and forms the basis of the project monitoring system. Once the indicator has been identified, it should then be developed to include brief details of quantity, quality and time (QQT), and location. Objectively verifiable indicator means that different persons using the indicator would obtain the same measurements. This is more easily done for quantitative measures than for those that aim to measure qualitative change. It is often useful to

include more than one indicator if the single indicator does not provide a full picture of the change expected. At the same time, the trap of including too many indicators should be avoided, as this will add to the work and the cost of collecting, recording and analysing the data. OVIs often need to be specified in greater detail during implementation when additional information is available and to allow for effective monitoring.

2. *Sources of Verification (SOVs)*

When indicators are formulated, the source of information and means of collection should be specified. This will help to test whether or not the indicator can be realistically measured at the expense of a reasonable amount of time, money and effort. The SOV should specify:

- the Format in which the information should be made available (e.g. progress reports, project accounts, official statistics, etc.)
- who should provide the information
- how regularly it should be provided. (e.g. weekly, monthly, quarterly, annually, etc).

3. *Sources/Means and Costs*

'Means' are the human, material and financial resources required to undertake the planned activities and manage the project. In order to provide an accurate estimate of the means and costs required for a project, planned activities and management support activities must be specified in sufficient detail. An area for particular attention is the cost of collecting data on OVIs.

4. *Assumptions*

It will have become apparent during the Analysis Phase that the project alone cannot achieve all objectives identified. Once a strategy has been selected, objectives not included in the intervention logic and other external factors remain. These will affect the project's implementation and long-term sustainability but lie outside its control. These conditions must be met if the project is to succeed, and are included as assumptions in the fourth column of the Logframe. However, one must beware of 'killer' assumptions!

There is a proverbial statement that says 'Many are called; only a few were chosen'. This is directly related to funding agencies. Many researchers submit proposals for grant but because the grants available from different funding agencies are limited, only a few researchers that meet the requirements of the proposal writing will be awarded. Any time you are competing with other potential researchers/scientists all over the world, try to search diligently the thematic areas of donor agencies and follow the rules of the competition. You are likely to be among a few scholars to be chosen after short listing, technical evaluation and other requirements of proposal writing by the panel of judges.

Two operational examples of LFA in Discipline oriented proposals (Forestry and Community Health) are provided to fill in the 16 missing gaps/linkages in the 4 X 4 LFA Matrix as presented in tables 5.2 and 5.3.

Example 1: Assessment of Community Forest Participation in Ogun, Osun and Oyo States of Nigeria.

The specific objectives of this project are as follows:

i. To review trends in CFP in Ogun, Osun and Oyo states and to draw lessons that would ensure effective SFM in Nigeria
ii. To examine the existing institutional arrangement and implementation framework for CFP in the three states.
iii. To examine benefit sharing mechanism and problems in the three states.

Example 2: Assessment of Long Expectancy in Individual Life in some selected Local Government Areas of Osun State, Nigeria.

The specific objectives for the second example are as follows:

i. To determine the quality of features that prolong life
ii. To examine the rate of medical check up
iii. To investigate conflict management in households

Table 5.2: Logical Framework on 'Assessment of Community Forest Participation (CFP) in Oyo, Ogun and Osun States of Nigeria'

4 x 4	Project Narrative	Objectively Verifiable Indicators	Means of Verification	Assumptions /Risks
Goal	Sustainable forest management and improved livelihood of people	CFP will be more successful in Nigeria in the next 5 years	Annual Forestry Report and evaluation Report	Willingness of all stakeholders in CFP
Purpose	To draw lessons on CFP and to disseminate recommendations on policy options for SFM in Nigeria	Two articles and one workshop in attendance of 10 participants in the 8th quarter	Scientific Journals and workshop proceedings	No hindrance to implementation of activities
Expected Output	1.Lessons on CFP draw and compared as a way forward in Nigeria 2.Lessons on institutional arrangement as a way Forward 3.Lessons on benefit Sharing 4.Dissemination of information on lessons learnt from CFP	1.Two scientific articles on CFP between 2nd and 3rd quarters 2. Two scientific articles on institutional arrangement in 4th quarter 3.Two scientific articles on benefit sharing mechanisms in the 5th and 6th Quarters Workshop in attendance of 10 stakeholders in the 8th quarter	1.Scientific Journals 2.Scientific Journals 3. Scientific Journals 4. Manuals/workshop proceedings	1.No hindrance to literature 2. Sincerity of Stakeholders 3.Acceptance of information Provision for dissemination of findings
Activities	1.Assessment of extent of CFP 2.Determination of capacity in areas of human, finance and facilities for community to participate 3. Assessment of patterns of distribution of benefits and the mechanisms to ensure equity 4.Dissemination of findings through media, journals, policy briefs and stakeholders' workshop	1.Review of literature 2.Meeting schedule with all stakeholders between 2nd and 3rd quarters 3.Adminstration of structured questionnaire To 500 selected households in 2nd and 3rd Quarters 4.Publication of articles in reputable journals between 3rd and 4th quarters	1.Progress reports 2. Progress reports 3.. Local News media 4. Findings in Scientific journals such as Nigerian Journal of Forestry, workshop proceeding, etc	1.Unimpeded access to literature, website, internet, textbooks. 2.Availability of funds and logistics 3. Willingness to accept 4. Acceptability of articles.

Table 5.3: Assessment of Long Expectancy in Individual Lives in Some Selected Local Government Areas of Osun State, Nigeria

4 x4 Matrix	Project Narrative	Objectively Verifiable Indicators	Means of Verification	Assumptions/Risks
Goal	To have a long productive life	80 years of life that is free from chronic diseases	Medical records	No genetic/ congenital problems
Purpose	To maintain good health	Pass all health evaluation every year	Medical records	Strong motivation
Expected Output	1. Good health habits adopted 2. Medical care made use 3. Stress managed	1. Pass annual health evaluation 2. Pass all laboratory tests every year 3. Pass all annual psychological evaluation	Health habit evaluation reports Laboratory tests results Evaluation results	No accidents Not exposed to environmental hazards Adequate finance
Activities	1.1. Sleep 1.2. Work 1.3. Nutrition 1.4. Exercise 1.5. Hygiene 2.Medical checkup 3.Conflictmanagement	1.1.Uninterrupted 7 hours of sleep every day 1.2. 7-8 hours a day without overstress 1.3 Fruits and vegetables every day and regular hours(Budget: N10,000/ Month). 1.4. Jogging 20 minutes a day in your environment 1.5. Tidy environment 2. Complete checkup for 6 months (Budget: N10,000/Month) 3. All conflicts resolved the same day they occur peacefully	Sleep log Office attendance sheet Nutrition log Exercise log Hygiene log Medical records Schedule book/Diary	No thieves Full employment Food is available and affordable Facilities available The drainage is freed of blockade Medical services available and affordable Stress management skills are acquired

NOTES

Wood, P. 2001. The Logical Framework Approach- A project Design and Analysis Tool. Training Courses Handbook *.AAS and ISRA/CNRF CBFR Third Workshop Training and Symposium, Insitut Senegalais De Recherches Agricoles*, CENTRE NATIONAL DE RECHERCHES FORESTIERES, Dakar, Senegal. 03-07 December, 2001.

Having read and digested the theory on LFA above as taught by Dr. Peter Wood in *AAS and ISRA/CNRF CBFR Third Workshop Training and Symposium, Insitut Senegalais De Recherches Agricoles*, CENTRE NATIONAL DE RECHERCHES FORESTIERES, Dakar, Senegal. 03-07 December, 2001, it is advisable that the users be patient enough to study the LFA as a useful guide for proposal writing.

It is advisable to state a few objectives that could be achievable within the time frame of your research.

6

SYSTEMATIC COLLECTION OF DATA

G. A. T. Ogundipe, E. O. Lucas & A. I. Sanni

WHAT IS 'DATA'?

Data are the symbols, numbers and or alphabetical characters used to describe one or more attributes such as age, sex, volume, growth rates, temperature, etc. of an entity. Data are obtained by observing, counting, measuring, weighing etc which are then recorded. It is also regarded as the building blocks of information.

The terms data and information are often used interchangeably in everyday speech as meaning the same thing, but in reality, they have distinct meanings. They are the input raw materials from which information is produced. Information can therefore be defined as data that have been assembled, processed and interpreted into a meaningful way. Information could be in textual, pictorial or vocal form. The purpose of acquiring information is to increase knowledge, reduce uncertainty and facilitate decision- making.

Data can be of three types:

- cardinal or numerical data or discrete variables (quantitative) are those which can only take certain values. An example is the number of nodes in the cowpea plant. This number must be an integer such as 0,1,2,3, etc.
- nominal or categorical data are simply facts that can be sorted into classes and enumerated such as colour and breed.
- ordinal or continuous variables are those that have

ordered relationship to one another and can take any value in a certain range. For instance plant height is a continuous variable. If one plant has a height of 20 cm and another a height of 21 cm, it is possible to find a third plant with a height of between 20 and 21 cm. For continuous variables, measurements are approximate because they have to be rounded off to a whole number or to a fixed number of decimal places.

Table 6.1 Classification and Types of Data

Types	Attributes	Examples
Dimensional-quantitative	As discrete measurements	Numbers of ...
	As continuous measurements	Height, Pressure, Weight, Age,
Categorical	Nominal (named)	Breed, sex, location
	Ordinal or ordered	Larva, adult, male

RESEARCH DESIGN

A good way to approach the planning of a study is to take the view that the researcher is buying information. The investigator must make sure that the study produces the data required at the lowest possible cost.

Definition of the problem

The first step is to state the problem one is dealing with clearly and consistently. For example, the problem may be how to increase yield of a particular crop with nitrogen fertilizer.

Statement of objectives

The investigator needs to write out clearly the objectives of the study and the data that need be generated to attain them. If the resources available may not permit the attainment of the original objectives, the objectives may have to be redefined or additional resources found. Precise aims and objectives need to be specified. Vague aims produce vague studies. Objectives can often be defined by constructing hypothesis.

Formulation of hypotheses

Hypotheses formulation is one of the ways by which the broad problem being researched into is reduced to testable forms. Hypotheses ought to be formulated before the collection of data. A hypothesis is a tentative or intelligent guess, an idea that is suggested as a possible way of explaining a situation, which can be tested by facts that are known or can be obtained. Hypotheses, therefore, represent some form of theoretical models, which are specifically meant to coordinate and give direction to the research. Hypotheses are usually stated in declarative sentence form. Hypotheses stated in question forms are referred to as Research Questions. Hypotheses are often derived by a careful consideration of the existing knowledge in the field, by intuition and from a theory already postulated (Akinboye 1997).

The following criteria are pertinent in selecting good hypothesis statements.

1. Hypothesis should be a statement about a relationship between or among variables.
2. Hypothesis should carry clear implications for testing the stated relationship so that the logical consequences or implications of such relations could be confirmed or disconfirmed.
3. Hypothesis must be consistent with known facts.
4. Hypothesis should obey the law of parsimony i.e., it should be as simple as possible.

Null hypothesis is that which is stated so that no difference or no relationship is hypothesized. It is a non-directional hypothesis. e.g. Students' sex will have no significant effect on their employment after graduation.

A research or alternate hypothesis is a statement of what one expects to find from an experiment or test. It is directional and usually made in the positive e.g. Students' sex will be significantly related to their kind of employment after graduation.

Method of investigation
The selection of appropriate method of investigation, appropriate sampling method and sample size where relevant, is essential.

Quality assurance
Frequently, considerable attention is given to the methods of processing data while the quality of the source data is taken for granted, but if the source data are flawed, any resulting information will be worthless. There is a need to ensure maximum validity and reliability. The validity of a technique is its ability to provide an accurate measure of a concept, which is relevant to the hypothesis being tested.

Consistency
The data must be consistent so that *any change should be the result of a change in the characteristics being measured, not the result of an unreliable measuring instrument or technique*. This is also referred to as "test-re-test reliability" (Bailey 1987, p72). For data to be consistent, they must be collected in the same manner using the same techniques and the measurements should yield consistent results.

Bias
Bias is a systematic error, resulting in over- or under estimation of the strength of the association. Miscalculation must be avoided. Bias can be avoided by the use of 'blind' technique whereby the observer is kept ignorant of the distribution of the determinant in the group being studied.

Studies are often conducted with the help of enumerators, usually field staff. Variations between different observers may occur when some degree of objective judgment is involved. Uniform criteria need to be established to be used by all those engaged in the study. There must be careful monitoring and checking of all apparatus to be used during the study to reduce errors.

DATA COLLECTION
There are three basic techniques available to collect research data. These are interviews (both face to face and via questionnaires), observation and examination of existing records.

Interviews (both face to face and via questionnaires)
Face to face interviews offer a number of advantages. They are flexible; ideas can be followed up and reactions probed further. The response rate tends to be higher than when questionnaire survey is conducted. Interview may be used to eliminate some of the problems encountered in questionnaire-based research, such as ambiguous wording, ill-defined categories and inadequate measuring instruments. Considerable time and patience are needed to obtain the interest and cooperation of individuals.

Interviews using questionnaires are useful where face-to-face interview is not feasible due to a large sample size. In places with good postal services, data can be collected quickly and cheaply by circulating questionnaires. They are of little use where the target population is illiterate. Questionnaires involving considerable efforts in filling will likely lead to a high non-return rate.

Contents of a questionnaire
Questionnaires may contain open-ended or close – ended items or questions. In open-ended items, the subject uses his own words to describe the response while in close ended items, responses are stated and the subject is forced to choose one of them or to rank them.

Items may reflect the Likert scale (Anon 1997) which show agreement or disagreement with a statement through a choice. An even number of choices (called a forced choice) precludes taking a neutral or midpoint choice. An odd number of choices allow a respondent to take a neutral position. The number of choices should be based on the sophistication of the respondents.

Longitudinal scale – place or spot on the scale that you feel best represents you, a plain rating scale.

Observations and measurements
If a high degree of precision is required, especially in experimental studies, the variable will have to be determined in such ways as observing, weighing and measuring. It is the primary

technique for the collection of non-verbal data. Bell (1993) suggests that this method reveals characteristics, which are impossible to discover by other means.

Persons taking the measurements must master the use of measuring equipment before the survey begins. The equipment should be calibrated and checked for accuracy before the start of each series of measurements.

If a researcher is interested in gathering data on human actions, as opposed to beliefs, values, or opinions, direct observation of the act by the researcher would seem to have superior face validity over data collected by questionnaire and document study. Observation will allow the researcher to record what is actually happening, but it will not necessarily reveal why it happens.

Study of existing records

Since collection of data involves a considerable amount of time and effort, the possibility of using existing data normally collected during routine services, should be explored. Examples include records from hospitals, diagnostic laboratories, abattoirs, farms, meteorological offices, courts, schools and office of statistics.

Existing data is cheaper but not cost free and the analysis of such data gives answers more quickly. With data from various sources, it may become possible to monitor the different populations and to establish linkages between the events. Since original data collection was performed in ignorance of the ongoing study, there may be a reduced chance of bias in favour or against any hypothesis being tested. Record examination.

Existing data must be used with caution since such data are often incomplete, of unknown consistency and may not be relevant. All the records might not have survived to allow for fair representation of sample.

SAMPLE SELECTION

Population

Population is described as the totality of all elements, subjects, or members that possess a specified set of one or more common definite attributes. When a very large or limitless group is being considered, it is called continuous population but if a specific group such as a class in a school is used for a study, it is called discrete population. The population must be clearly defined. Most empirical researches often begin with the specification and definition of the target population.

Sampling

In many cases, the population is infinitely too large to be managed within a reasonable time for the study. A representative or sample of such a population is therefore selected. The process of sampling involves defining the population, drawing a sample from the population and making statistical inference (fig. 5.1).

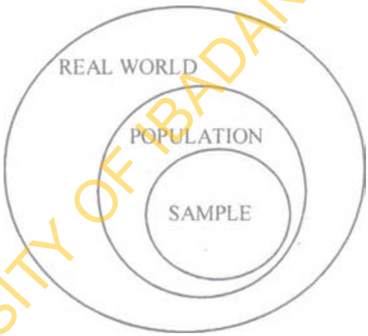

Fig. 6.1 Population and sample

When should one sample?

Sampling should be done when the population is large, inaccessible or when costs for sampling the population are excessive. An appropriate sampling technique must be used and the sample must be large enough to represent the population. The sample of cases studied must represent the entire spectrum of the problem. For example, if the population to be studied is a field of maize and if the objective is to estimate the average yield, it may be impracticable to measure individual yield of every plant in the field. In some cases, the number of the maize plants in the field may be running into thousands judging by the current recommended plant population of 80,000 plants/hectare. A way out is to take random samples in the field.

A crop sample is therefore a small portion of the population, taken for detailed studies. It may be a length of row, quadrant area, a number of plants or pots taken at random. Hopefully it will be representative (large) enough to inform the researcher what he or she needs to know about the whole population of a particular treatment.

If a sample is taken for the estimation of a parameter e.g. height of the maize, it should be noted that the estimate could be 'a long way' from the true value of the average height of the population. A statement is needed on how close the sample is likely to be to the population mean. For example, it would be helpful to state with 95% confidence that the mean height per plant is between 81 and 85 cm. The calculation of a confidence interval requires some background theory and in the following discussion, a population of field plants is assumed.

N = population size which may be total number of maize plants in the field. It is likely to be very large and unknown. For example, a farm crop of maize will consist of approximately 8 plants/m^2 or 80,000 plants/hectare.

ì = population mean: This is rarely known. It may be the mean height of all the plants in the field. If all the plants were measured, ì would be calculated by adding all the heights and dividing it by N.

The formula for ì is

ì = (Ó X)/N

X is the symbol used for height and Ó is the summation sign. It means add up all the Xs (the heights).

As it would be impractical to access the height of 80,000 individual plants, an estimate of ì can be found by taking a sample from the population. To be unbiased and representative of the population, the plants to be chosen for inclusion in the sample must be selected at random. In this way all individuals in the population have an equal chance of being included in the sample.

n = sample size (this may be the number of plants in the sample)
x_1 = height of first plant in the sample
x_2 = height of second plant in the sample
x_n = height of n^{th} plant in the sample

using Ó sigma notation

ÓX = x_1 + x_2 + ...x_n

x is the symbol for sample mean and its formula is

x = ÓX / n

Sampling Methods

Systematic sampling

With this technique, each element in the population is allotted a number. The researcher may select every 10^{th}, 20^{th} or Nth element of a population until the desired sample size is selected.

Simple random sampling

The principle of random sampling is that every element of the population is given an equal chance of being selected for study. The exact size of population must be known. The first step in random sampling is to construct a list of all the individual sample units (sample frame) in the population being sampled. Each element is allotted a number. The table of random samples could be used to select a random sample.

Stratified random sampling

When a population is heterogeneous, it might be necessary to first stratify by dividing it into a set of mutually exclusive sub-populations or strata, which could be race, sex, and religion. Random samples are then selected from each stratum.

Multistage sampling

When a population is greatly heterogeneous and it is difficult to develop the sample frame of individual elements, it might be necessary to select random samples in stages. For example, a researcher might randomly select some villages within a state as a first stage; at another stage he can randomly select some schools within his selected villages. At the third stage, he randomly selects some pupils within the selected schools.

In order to obtain a representative sample of school children in a large city, it would be more convenient first to draw a random sample of schools and then within each selected school to draw a sample of children.

DATA COLLECTION UNDER DIFFERENT TYPES OF STUDY

Historical Research

The purpose of this type of research is to obtain a better understanding of the present situation through the evaluation of the past and therefore making an intelligent prediction of the future. This type of research is very useful in the following ways:

(i) aids in avoiding past mistakes,
(ii) builds on what is known and
(iii) aids in predicting the future. Examples include archaeological studies.

Data collection

- Interview – An actual eye witness or participants in an event may be interviewed.
- Documents – The primary sources of data include documents, relics and other things that have direct physical relationships, or if it is an ancient or more recent historical object, the remains itself e.g. the Olokun bronze statue. Secondary sources are materials that have been recorded or documented by someone who collected information from direct or indirect sources. Examples include bibliographies, references and other materials that have indirect contact with the main source.

Descriptive Research

A type of research, which is used to find the meaning and obtain understanding of the present conditions, beliefs, attitudes, a careful study and methodical observation of a particular event in the real world. This method does not manipulate any variable but carefully observes and records information as they occur when the study is being conducted. A study of the prevalence of a disease in a population is an example. The population must be well defined and sample should be carefully chosen.

Data collection

- Interview – The study may involve the conduct of an interview in the chosen sample.
- Observation and measurements – This has to do with active utilization of all senses. See Table 6.2 for relevant examples.
- Documents – Data collected from routine services may be useful.

Experimental Research

Experimental research is a process of systematic and logical procedure which examines, identifies and evaluates the causal relationships between variables in any state of affairs. An experimental study involves the manipulation of the variables to ascertain that one is related to or has an effect on the other.

Experimental research may be conducted to test the potency and safety of a new drug or the effects of the application of different levels of a particular fertilizer on a certain variety of crop. There are basically four types of variables. These are Dependent, Independent, Intervening and Extraneous. Interven-ing variables are those that cannot be directly measured though they participate in the resultant effect of a study, e.g., quality of materials and the skill of the scientists. Extraneous variables are those that prevent changes in dependent and independent variables. Unlike descriptive research, the researcher is not only a keen observer of events, he deliberately manipulates the independent variable (I.V) while he observes and measures the dependent variable to see whether there is any effect brought about by the manipulation of the I.V.

In an experimental research, at least one group must be con-

Unlike descriptive research, the researcher is not only a keen observer of events, he deliberately manipulates the independent variable (I.V) while he observes and measures the dependent variable to see whether there is any effect brought about by the manipulation of the I.V.

In an experimental research, at least one group must be controlled and its independent variable is not manipulated. Critical error stages, which determine acceptance or rejection of an experimental result, have to be carefully selected.

Data collection

Observation and measurements

This has to do with active utilization of all senses possibly with the aid of relevant equipment (Table 6.2) as for descriptive research.

In an experimental study, data can be collected once, usually at the end of the experiment. We can describe this system of data collection as **System 1.** Data can also be collected at given intervals during the course of the experiment. We can describe this system of data collection as **System 2 (see fig. 5.2). System 1** is less tedious, less costly and less time consuming than **System 2** but it may not be possible to interpret with certainty the factors that led to the results obtained as it is not possible to have an in-depth discussion of other factors that mediated the results obtained. **System 2** also provides useful background information, which may be used to interpret and discuss the final results. For example, when regular descriptive samples are taken in crop production research, the effects of treatments on plant morphology and reproductive components or yield can be determined. With these measurements data can be analysed and interpreted in much detail. This system gives reliability to the results obtained.

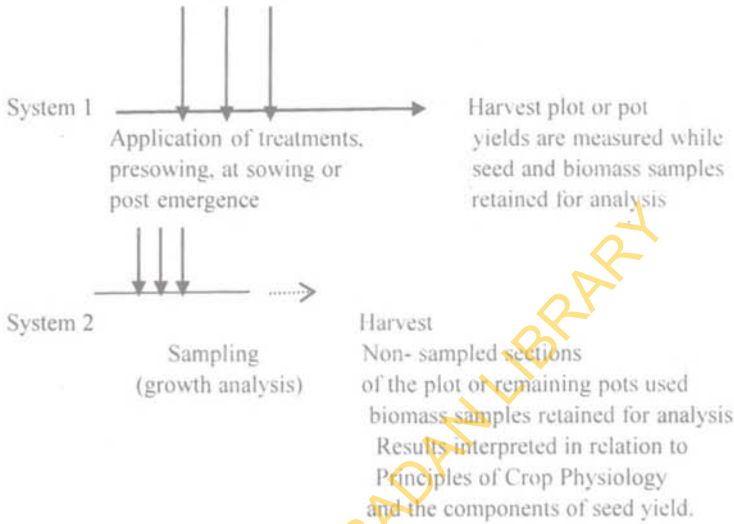

Fig. 6.2 The Two Systems of Data Collection in an Experimental Research

Evaluation research

A type of research that involves the collection of data in order to make decisions about the value of a product, project or technique. Studies on the performance of 6-3-3-4 system of education, guinea worm eradication project and efficiency of national disease reporting system are examples of evaluation studies.

There are two types of evaluation research. These are formative and summative.

- In formative evaluation, data are collected about a programme while they are still being developed. It determines the worth of the work and the need to modify.
- The summative evaluation is done after the programme has been fully developed or wound up. It determines the worth of the final programme in relation to similar types.

Data collection

- Interview – Beneficiaries and stakeholders may be interviewed on the performance and benefits of the project or scheme.
- Observation and measurements – A visit may be made to inspect and access the performance and products of the scheme.
- Documents – Records may be analysed.

Product developmental research

The focus of product development research is to design, develop and validate alternative or new products. Examples include the production of a new drug or the design of a new engineering product. The steps involved include; study prior research, establish goals and objectives, predict chance for success, develop the products, field test it and disseminate the results.

Data collection

- Observation and measurements – Observation and measurements during the process of developing the product
- Interview – Users of the product may be interviewed on the performance and benefits of the product during field test.

TABLE 6.2 EXAMPLES OF EQUIPMENT FOR DATA COLLECTION

Equipment	Uses
Atomic Absorption Spectrophotometer (AAS)	For elemental analysis e.g. calcium Spectrophotometer (AAS) magnesium, potassium, sodium in water, soils and plants
pH meter:	For determination of acidity and alkalinity level of any solution.
Flame Photometer	For determination of potassium and sodium in water and plant.
Colourimeter	For colourimetry analysis e.g. phosphorus in plant and soil Nitrogen in Plant
Auto Analyser	For automated analysis of colourimetry analysis in water e.g. PO_4, NO_3, NH_4. Nitrogen Phosphorus etc.
Electron probe Microscope Stethoscope	For measuring moisture content of the soil For visualizing small objects For measuring heart beats, pulse rate, respiratory rates etc in man and animals during clinical studies
Clinical thermometer	For measuring the body temperature
High Power Liquid Chromatography	For detecting and measuring levels of chemicals e.g drugs in biological products.
Barometer	For measuring air pressure
Wind vane	For determining wind direction
Anemometer	For measuring wind speed
Rain gauge	For measuring the volume of rain
Seismograph	For measuring earth vibrations and movements.
Light meter	For measuring light intensity
Global Positioning System (GPS) Instrument	For determine global positioning of an object

Table 6.3 Summary of Data Collection under Different Types of Study

Data collection	*Types of research*				
	Historical	Descriptive survey	Experimental	Evaluation	Product development
Sampling	Applicable	Applicable	Possibly Applicable	Applicable	Applicable
Interview	Applicable	Applicable	Possibly Applicable	Applicable	Applicable
Observation & measurement	Applicable	Applicable	Applicable	Applicable	Applicable
Existing records	Applicable	Applicable	Review as literature	Applicable	Review as literature
Quality Assurance	Evaluation of sources	Ensure accuracy of measure-ments	Control Ensure accuracy of measurements	Ensure accuracy of measure-ments	Ensure accuracy of measure-ments

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7

ANALYSIS OF QUALITATIVE DATA

A. S. Jegede

INTRODUCTION

Analysis of data generally requires that the investigator must systematically examine data in order to understand patterns and, in some cases, to identify cause and effect relationships between dependent and independent variables. This process must be well documented so that other researchers can follow it, understand the decisions already taken and independently verify the results (Ulin, Robinson, Tolley and McNeill 2002).

Generally, qualitative studies are designed to understand the context (psychological, social, political or economic) in which research questions are situated. In doing this, the researcher must not only be interested in the responses provided by respondents but also the circumstances of the responses. Situating responses within specific context provides more meaning than making mere statements. As a result, to conduct qualitative research, multiple methods of data collection techniques must be put in place. This includes Focus Group Discussion (FGDs), In-depth interview (IDI), Key Informant Interviews (KII), Participatory and Non-Participatory Observations and Case studies/Life Histories.

Researchers using qualitative approach usually start with more general, open ended questions. They move towards greater precision as detailed information emerges (Ulin, Robinson, Tolley and McNeill 2002). Although review of literature may suggest that certain ideas are important for consideration in a particular research or study, it is not a usual practice to predefine variables while doing qualitative research.

This is because qualitative research by itself is explanatory. It always sets out to generate new ideas or information that can provide basis for variable definition or theoretical development/ formulation. As a result, certain ideas or concepts are better defined with new data collected from the field. In fact, this makes preliminary analysis an important aspect of data collection. Therefore, it can be said that qualitative analysis starts with the first field experience. This may lead to revisions of research instruments as the study progresses. Generally, researchers are yet to agree on the pattern of analysis for qualitative study. Nevertheless, qualitative data are analysed by researchers using methods or approaches known to them.

Hence, the aim of this paper is to demonstrate how raw data from qualitative research, whether transcripts from FGD tapes, field notes, or other written materials, can be processed and interpreted to provide answer to important research questions and at the same time address theoretical issues. The presentation, therefore, focuses on principles of qualitative analysis, processes used to analyze qualitative data including reading, coding, and data reduction, data management, interpretation of data, and integration of qualitative data into mixed method designs. It also discusses how to write qualitative research report.

WHAT ARE QUALITATIVE DATA?

Qualitative data may be generated through primary source from direct interactions with participants and from observation. It may also be from secondary sources, including numeric or textual data from hospital records, or summaries or full texts, from newspapers, popular literature, academic reviews, and other sources (Ulin et al. 2002:138). In this paper, reference is made to data generated from direct interaction with participants through FGDs and in-depth interviews.

FIVE PRINCIPLES OF QUALITATIVE ANALYSIS

The following five principles have been identified to guide qualitative analysis (Ulin et al 2002):

- Individual Differences: People differ in their experiences and understanding of realities. The researcher's assumptions may not be similar to how participants define a situation. According to Cooley, it is therefore important for researchers to take note and account for the cultural lens through which they inevitably view research population (Kelly 1997).

- Context of Meaning: A social phenomenon cannot be understood outside its own context. It has been argued that it is important to pay attention to the language used in dialogue with study participants. Even when speaking the same local language a participant and researcher may in fact be speaking from different vantage points – attaching different meanings to the common words being used (Ulin et al, 2002:136). Context does not only mean physical setting in which behaviour or attitude takes place, but also the historical, social and political climates, and organizational or individual characteristics that influence the phenomenon.
- Theory Building: Theory does not only guide qualitative research but also qualitative data may lead to theory. According to Glanz et al. (1997:22), "it does so by specifying a set of general or abstract concepts and their relationships to one another – the who of which can be used to explain or predict the behaviour, attitude, disease, or profess under study". Therefore, qualitative research can be informed by theory or it can generate theory (Ulin et al. 2002:137).
- Findings leading to further study: In some cases unique findings may be an eye opener to lead to study or investigation. It is important to find out why some individuals or groups may differ in their opinion regardless of whether majority of the participants reach a consensus or not. A minority view may sometimes bring an insight into a new direction of enquiry or information for further study.
- Processual Understanding of Human Behaviour: Human behaviour cannot be understood linearly but slowly. Since human behaviour is dynamic, it therefore, requires a flexible and integrated approach to understand complex issues from the perspectives of

participants. For example, during epidemics a researcher may want to analyse his/her data on the field to be able to develop intervention strategies. Further and rigorous analysis can follow later.

Characteristics to note when analysing a segment of text

Text can be read at many different levels. The more experienced you are the more you are able to recognize and incorporate these different levels in your analysis. The following are important features to note when analysing a segment of a text:

1. the primary message content;
2. the evaluative attitude of the speaker towards the message;
3. whether the content of the message is meant to represent individual or group-shared ideas; and
4. the degree to which the speaker is representing actual versus hypothetical experience (Ulin et. al. 2002).

BASIC STEPS IN QUALITATIVE DATA ANALYSIS

Specifically, qualitative analysis emphasizes how data fit together as a whole. It relates context to meaning. Many approaches of qualitative data analysis exist but a commonly used approach is the use of research questions to categorize or group data and then look for similarities and differences (Fig. 7.1). This approach can be used as a rapid procedure especially when a researcher is faced with limited time or resources.

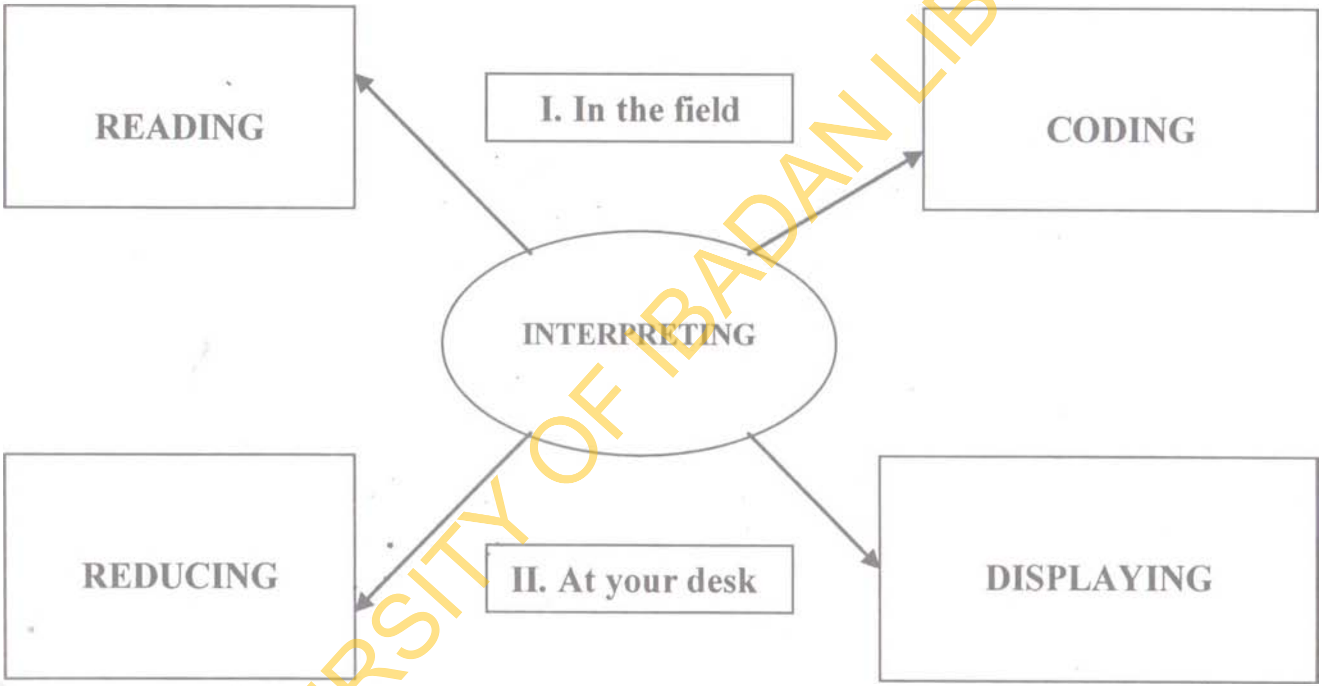

FIG. 7.1 Qualitative data analysis: Step-by-step

Source: Nuberman and Miles (1994) 'Data Management and Analysis Methods' In Denzin Nk, Lincoln, Y.S. (eds.) Handbook of Qualitative research.

Reading

It is important to develop an intimate relationship with the data. Most qualitative analysis starts with data immersion. This means reading and rereading each set of notes or transcript generated from the field until one is intimately familiar with the content. This does not have to wait until fieldworks have been concluded. It must start regularly with progressive review as data trickle in one by one. In doing this, the following must be taken into consideration while reading qualitative data.

Reading for Content. Researchers must be sure that the kind of information received are those intended to be collected. Also they must be satisfied that responses are comprehensive and detailed enough. These two objectives may not be achieved due to (i) inadequately framed or sequenced questions (ii) other aspects of the interview process may be inhibiting data collection e.g. venue, group composition, style or characteristics of the interviewer. As data are being reviewed, researchers should begin to identify emerging themes and develop tentative explanations. Identify any topics that have not been adequately examined, and one that have emerged unexpectedly in the transcripts. These may be typed directly into transcripts, by putting them in brackets or italics so that they can be distinguished from original text. Or ideas may be recorded in a field journal or typed in separate memos (Ulin et al, 2002:143).

Assurance of Quality. In the process of reading the data, adequate attention must be paid to the quality of the transcripts or notes. Such things as how data were obtained? Is it review of field observation? How soon after the field activities were notes recorded? How vivid and detailed is the description? How spontaneous was the conversation resulting from informal interaction in the field? What influence did researcher's attitude have on respondents in the field? All these must be seriously considered to evaluate the quality of data collected.

Identification of Patterns. Once field notes or transcripts are generated from several sources, they must be reviewed as a set to identify important themes. It is important to begin to examine how these themes are patterned. According to Ulin et al. (2002), "patterns may include those that occur in all or some of your data, possible relationships between themes, contradictory responses, or gaps in understanding". In fact, gaps suggest new ideas or questions to be further explored.

Coding. When researchers have read through and become familiar with the first texts, then they can begin to code the themes. Codes are like street signs, inserted into the margins of handwritten notes or typed after segments of texts to remind one where he is and what he sees (Ulin et al. 2002: 144). The use of words or parts of words to develop ideas one discovers in the transcript can make analysis of a large data file easier and more accurate. When the key themes are coded, one can later search and retrieve interesting segments and look at them as a separate file. Researchers differ in how to derive codes, when to start and stop coding. However, when more than one person is involved in coding, develop a process to negotiate or reconcile coding decisions. One must be guided by what is most useful the way text is organized and sensible. Also remember to document decisions made about coding.

EXAMPLE OF A CODING DATA

> Sometimes I make move to my husband and sometimes he makes move first when we are about to make love (*Sexual Decision Making*). We use condom occasionally especially during menstruation (*Condom used*). We take the number of children as provided by God (*fertility decision making*). I take money from my husband and go to hospital of my choice, provided it is a government hospital (*financial provider*). Contraception is taken for spacing of children (*Knowledge*). Decision is taken together with my husband, over the choice of infant food (*Household Decision making*). Medical advice is given for the type of contraceptive method (*Health seeking*).

Key: Code appears in italics and bold.

Note: Several themes emerge from this excerpt and help us to understand the relationship between sexuality and decision about use of contraception. They include:

1. Description of sexual relationships
2. Decision making about sexual intercourse
3. When condoms are used
4. Fertility decision making
5. House household decision making generally.

These categories may look sufficient initially dealing with few interviews. But when it involves many interviews you will find out that such broad headings give you little sense of the main ideas emerging from your data. You will therefore need to develop new codes that divide these themes into smaller components, or sub themes (Ulin et. al. 2002).

USE OF COMPUTER SOFTWARE IN QUALITATIVE ANALYSIS

The computer revolution has not only improved analysis in quantitative study but it has also been useful in qualitative analysis. For many decades, quantitative researches have been conducted using handwritten notes and interviews, and transcribed verbatim by hand. Ideas and messages are distinguished by underlined text, written codes into the margins or pages, or otherwise highlighted segments of prints. Data are organized through cut and paste system while sorting are done thematically. Not all researchers still accept the role of the computer. They argue that it distances the researcher from the text. Nevertheless, computer software programmes have been found useful in that they enhance qualitative analysis by performing a number of basic data manipulation procedures which ordinarily could not have been possible using free hand. For instance, creation and insertion of codes into text files, (see Table 7.1), indexing construction of hyperlinks and selective retrieval of text segments (Kelle 1997).

Themes	Codes	Definition
1.1 What is the ideal Age for marriage for girls		
• 12 – 13 • 14 – 19 • 20 – 21 • Greater than 22 years • Ambivalent • Others	G1112-13 G1114-19 G1120-21 G11ABOV22 G11AMBV G11OTHER	
1.2 What is the ideal Age for Marriage for boys		
• 15 – 20 • 21 –24 • 25 – 30 • 31-35 • Above 35 • Ambivalent • Others	G1215-20 G1221-24 G1225-30 G1231-35 G12ABV35 G12AMBV G12OTHER	
1.3 Reasons for Age Suggested for girls		
• Understand life • Will be matured • Others	G13UNDER G13MATUR G13OTHER	
1.4 Reasons for Age Suggested for boys		
• Comfortable • Knowledgeable • Mature • Gainfully employed • Have a means of livelihood • Others	G14COMFOR G14KNOW G14MATUR G14GAEMP G14LIVELI G14OTHER	
1.5 Ideal Age for boys to Start Sex		
• Below 15 years • 15years-20years • 21years-25years • 26years-30years • Above 30years • In Marriage • If he is matured • Others	G15BEL15 G1515-20 G1521-25 G1526-30 G15ABO30 G15INMARY G15MATUR G15OTHER	
1.6 Ideal Age for Girls to Begin Sex		
• Below 15 years • 15years-20years • 21years-25years • 26years-30years • Above 30years • In Marriage • If he is matured Others	G16BEL15 G1615-20 G1621-25 G1626-30 G16ABO30 G16INMARY G16MATUR G16OTHER	

Themes	Codes	Definition
1.7 Reasons for early sex nowadays		
• Parents no longer to stay with their children	G17NOSTAY	
• No home Training	G17NOHTRN	
• Because of sex education in schools	G17SEXED	
• Civilization	G17CIVILI	
• Indiscipline	G17INDISC	
• Poverty	G17POVER	
• No proper care	G17NOCARE	
• Others	G17OTHER	
1.8 How common is pre-marital sex in the community		
• Common	G18COMON	
• Not common	G18NCOMON	
• Ambivalent	G18AMBV	

Essentials of Software in Qualitative Data Analysis

The following must be taken into consideration while choosing qualitative data analysis (QDA) software:

- How complex are the data
- How complex is the analysis:
  - Meeting the goal of summarizing individual topics
  - Description of the way different topics are related to each other.
  - Ability to import and export data
  - Amount of socio-demographic variables involved
- Resources available
  - Staff
  - Time
  - Computer facilities (MacQueen, 2002)
- Characteristics of simple qualitative study.
  - Limited descriptive goals e.g to summarize the range of responses on five or fewer major topics.
  - Limited data needed to achieve the goal. E.g. 20 IDI, 10FGDs
  - Analysis will be done by 1-2 persons.
  - Little or no socio-demographic data to be used during the analysis e.g sex and ethnicity.

- Software needs based on study complexity:
- Moderately Complex:
  - An explanatory goal.
  - A moderate amount of data 10-20 FGDs, 20-50 IDIs.
  - Analysis team to have 2-4 persons.
  - More than five major topics to be covered by the study, with overlapping issues within at least some of the topics.
  - Limited socio-demographic data to be used during the analysis e.g not more than 20 variables.
- Complex Study:
  - A major scientific goal e.g theoretical modeling or hypothesis testing.
  - Data collection on a large set of topics that are organized into hierarchies or networks of information.
  - Very large volumes of text e.g <1000 pages or >100 text files.
  - Detailed quantitative measures or descriptions that will be the qualitative results.
  - Coordination of one large analysis team (>5 people) or multiple small teams with discrete analytic tasks (MacQueen 2002)

An example of software package for qualitative analysis is Open Code Computer Software.

Open Code Computer Software

Open Code is a tool used for coding qualitative data generated from interviews or observations. It has been developed to specifically follow the first steps of the Grounded Theory Method. However, it can also be used as a tool for classifying and sorting any kind of qualitative information. It aims at creating a self-instructive programme that is easy to understand and use.

Features of the Open Code are:

- to import documents typed in any word processing program
- to assign codes to segments of the text
- to produce lists showing frequencies of use

- to search for single codes or combined codes in the documents
- to produce lists of search results
- to print the results from any of the functions

Documents (text files) are imported into a project where they will be stored as lines with line numbers. Codes that are freely made up can be assigned to the lines. Functions like printing, code listing and search are included. In the main window of Open Code, one views a document in the project and does most of the coding.

A project can consist of many documents. The names of the documents are displayed in a LIST BOX at the top where one can select the one to work with. The text of the active document is displayed in the document grid which takes up the main part of the window. The controls to the right of the document LIST BOX are the coding tools. One selects a group of lines by clicking on the row numbers of the document. The existing codes in the selected area are shown in the Assigned codes list box. One can enter a code in the Assign code text box and add it to the selected text lines by clicking the Add button. The Remove button can be used to delete a code.

In the menus one can select other features. In the File menu one can create a new project or open an existing and import documents from text files. Functions to delete or rename a document are also found in the File menu.

A document consists of text lines with codes but also a comment. One can view and update the comment and get some statistics like the number of lines. This function is used through selecting Document Information in the File menu.

Use Print in the File menu (or press Ctrl+P) to print the active document. One can change the font and font size and line spacing. In the Code menu one will find functions to list codes and search and a function to globally rename a code. Code lists and search results can be printed.

Also most software help to construct indexes. In fact, most software enable one to conduct simple word searches. Hyper-link enables one to cross reference or link a place of text in one file with another in the same or different file.

Data Display. This means laying out or taking an inventory of what are related to a theme. Having done this one can now turn attention to capturing the difference, or richness of each theme, separating qualitative and quantitative aspects and taking note of differences between individuals or among sub-groups.

Data Reduction This simply means organizing the information to show the essential concepts and relationships. Data reduction usually takes place once all the data are in and one already familiar with the content. The aim of data reduction is to have general sense of the data and to distinguish between primary and secondary themes. It also enables the process of separating the essential from the non-essential. In order to get this wider perspective on the data Ryan and Bernard (2000) suggested that it will be helpful to use visual devices. For instance, matrices, diagrams, or taxonomies can be developed for each thematic file that has remained primary to the study. For instance, the ZY Index table is a good example.

Table 7.2 Index Table

Knowledge of HIV/AIDS	Single Unmarried 10-24 Years	Single Married 10-24 Years	Adult Single 25-49	Adult Married 25-49
Disease that cause untimely death	**	**	***	****
Killer disease	***	****	****	****
A disease caused by mosquito	**	**	**	***

Key:

***** represents **Most** participants

*** represents **Many** participants

** represents **Some** participants

* represents **Few** participants

Interpretation of Data. Interpretation is an essential part of data analysis. It tries to identify and explain the "core meaning" of the data. It does not only try to ensure essential meanings of qualitative data, it also ensures that the interpretation offered is "trustworthy". Interpretation of data also tries to ensure the question on how to approach interpretation when a study in-cludes both qualitative and quantitative data collection methods.

Data interpretation involves communicating the essential ideas of a study to a wider audience, remaining faithful to the perspectives of the participants (Ulin et al. 2002). Interpretation of data aims to identify ways in which most of the emerging themes and sub-themes, connections, and contradictions fit and what it all means. The meaning generated from the data must not only reflect the perspective of the participants, it must also address the interest of the larger population in such a way that it answers questions of social and .theoretical importance.

Integration of Qualitative Findings into Mixed Methods Design

Triangulation of methods has been used to generate data. It has proved better than when a single method of data collection is used as the methods corroborate each other. But the problem so far is how to integrate the methods in a single report. The first step in integrating qualitative to quantitative findings is to first of all analyse each data separately using procedure associated with its paradigm. Having done this, integration of the findings will now depend on the objective of each component and the study design. This determines whether both findings have equal weight in the study design or not. Although the two components of a mixed-method design are conducted sequentially, one is considered the main study (Ulin et al. 2002). Linking qualitative and quantitative analysis may be fairly straightforward especially when these data are conducted sequentially. But this may not be the case in a situation when they both have equal weight (Tashakkori and Teddie 1998). In a situation where data from qualitative and quantitative research do not agree, the researcher must look for explanations that reconcile the initially contradictory explanations. This may require additional analysis of either or both types of data.

However, in a situation where some findings prove irreconcilable, the researcher can present .the divergent interpretations and allow readers to draw their own conclusions. As a result, it is important, when this happens, to provide sufficient information on the data collection and analysis strategies in order to allow readers evaluate for themselves the credibility of your interpretations and perhaps to arrive at different conclu-sions (Ulin et al. 2002).

REPORT WRITING

For any research to be meaningful and useful there must be a written report. Report summarizes the data and provides explanation logically for easy reference. The process of writing up qualitative data involves determining the audience, and purpose of the report, revealing one's point of view in relation to the data, and dealing with special issues of trustworthiness. Generation of insight and meanings by study participants sharing their stories has practical and ethical implications for how researchers report findings from their studies (Ulin et al. 2002). Therefore, it is important to understand qualitative reporting conventions before beginning a study, and apply them to one's research process.

Ethical Norms Guiding Report Writing

According to Denzin (2000:902-903), the ethical norms that govern how to write about people's lives include, "the four non-negotiable journalistic norms of accuracy, non-malfeasance, the right to know, and making one's moral position public". Whenever a researcher is writing about sensitive issues, he/she must remember these four basic principles. In doing this, the researcher must do the following:

(a) Attempt to maintain balance and accuracy, and not neutrality. Multiple sides of the story must be presented in order to understand, and elicit the knowledge and insight of the research participants and present their insights in context.
(b) Guarantee that no harm comes to participants.

Published findings from a research should not cause any harm to participants.

(c) Give public voice to findings by sharing participants' own words. The tradition of presenting insights of study participants in their own words in qualitative research is both a philosophical commitment and a qualitative writing norm (Ulin et al. 2002: 168). By presenting partici-pants' perspectives in their own .words, one empowers them and conveys important contextual information to readers, such as depth, detail, emotionality, nuance etc (Denzin 2000).

(d) Describe the context of your interactions and discuss the role played by you.

Choice of Presentation Style

First of all, there is the need to clearly state the purpose about the target audience. It is important to say whether you are writing to influence community opinion leaders, to inform policy-makers, or to promote change about a particular practice. Is it to further academic discussion with scientific colleagues, etc? When you are clear about the purpose and having identified the secondary objective, this will help to determine the audience to write for. It is also important that researcher must balance his/her aim with available resources. For instance, one must try as much as possible to gain the attention of the target audience. One way of getting an audience of health professionals to pay attention to your findings is to 'initiate conventional scientific writing styles which should be modified to suit the presentation of qualitative findings (Miller and Crabree 2000). Different audiences must be targeted and addressed appropriately.

How to Organize Qualitative Report

Variations occur in organizing qualitative writing due to modifications resulting from the need to make scientific report outline fit the research material. The type of information required by the audience should influence the outline. It is also important to take into consideration the theoretical background for the study. Such writing should also conform to standard scientific report but with certain variations in the ordering of contents as the case may be. The following are some of the approaches that can be used to organize our report.

Problem-solving approach

(a) State the problem and describe the importance of the research topic and its implications e.g. for health policies or practices or its impact on theory.
(b) Briefly describe your methods
(c) State what one have learned e.g. about individual reproductive health themes and concepts
(d) Offer your conclusions.

Narrative approach

(a) Tell the story chronologically by illustrating a problem or process e.g. factors hindering the use of health care services – step-by-step or from multiple perspectives
(b) In your conclusion, explain why and how the process occurs. For example, if your study examines access to modern health care facilities in more than a community, you might organize your findings site by site.

Policy approach

(a) Present a conclusion on why a process or behaviour occurs or fails
(b) Use the data to show how you arrived at this conclusion. Journalistic and policy-oriented reports typically follow this pattern for busy readers who have little time for reading a lengthy article until they have grasped the relevance of the material.

Analytic approach

(a) Organize findings in terms of the theoretical or conceptual framework used to develop the study.
(b) Describe what is learned and how it fits in to the larger framework. Regardless of the format chosen, the basic principles that hold for all scientific writing must be followed, that is; demonstrate a knowledge of available scientific literature, and get your facts right

(Rubin and Rubin 1995).

Once one has determined the audience and the basic format to use, it is important to read samples of excellent writings that address similar audiences. Look for such things as:

- How is the material organized?
- Does your material lend itself to this kind of format?
- How does the author describe his or her methods and analysis strategy?
- How has the author revealed his or her standpoint vis-à-vis the subject under discussion? (Richardson 1990).

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8

USE OF A RESEARCH QUESTIONNAIRE

J.O. OSIKI

INTRODUCTION

Over the years participants in a research study often have information that may be important to the study and that can be obtained simply by asking the participants. Such information can be made available through several sources as in oral and, or the form of a paper-and-pencil tests. Information got by way of the paper-and-pencil format is usually referred to as the questionnaire. Very often, the survey research relies almost entirely on questioning participants for its data collection; although, depending on other framing format, the experimental (intervention) studies as well as control-trials, also utilize the questioning method.

Derived from the old French term, questionnaire simply suggests a collection and, or a form, containing a set of questions addressed to a statistically significant audience for which responses (information) are elicited for a survey. A critical examination of a typical frame of a questionnaire also shows that it is a collection of item-statements as questions. Investigators (researchers) adopt this pattern when the intention is to determine the extent to which respondents hold a particular attitude or view. In this case, the investigator swiftly ask the respondents to kindly indicate their feelings by either agreeing or disagree(ing); and whatever the decision is, they can also qualify that decision either by strongly agree (ing) and, or strongly disagree (ing). This of course, was the basis for Rensis Likert formalization of his procedure through the creation of the Likert scale, a format in which participants are requested to strongly agree, agree, disagree, or strongly disagree or perhaps, strongly liked, liked, disliked or strongly disliked. It can also be sure, very sure, not sure, very unsure; strongly appreciated, appreciated, rarely appreciated, and so forth. The questionnaire consequently, is a less expensive way to gather information (data) from a potentially large number of respondents (otherwise, participants) in a survey study especially. Infact most psychological tests in use globally today, were once list of item-statements as questions which are assessment and evaluation tools prior psychotherapies (therapies-following medical paradigm).

The Origin of the Questionnaire

A single questionnaire may contain one and several purposes calibrated into its sub-themes for actual evaluation. The ability of the questionnaire to do this both in psychological and medical paradigms (and other fields) is not in doubt; but its history. Although some literature (Wikipedia, the free encyclopedia) sees Francis Galton as the inventor of the questionnaire, the origin of the question method is a mystery as the first set of human users are not known. Some of these users might have also followed the systematic adoption, without any handing over of documentation. While it is scholarly sound to avoid the issue on the etymology of the questionnaire and particularly in this context, the obvious fact is that the questionnaire is a regular and current usage in research studies whether in medicine, behavioural sciences and the humanities. Before the decision to use the questionnaire by a researcher from either the behavioural sciences and, or humanities these facts however, should be considered:

(i) the aim/purpose (objectives) of the study/survey.
(ii) active search and review of literature in relation to the intended study area/focus.
(iii) what the research vacuum that the present study sought to fill.
(iv) find out through a random opinion survey current views on the problem area.
(v) compare the opinion survey with the information from related studies (or literature) before the actual construction of the questionnaire is done. Such comparison could be undertaken through the FGD.

Type and Relevance of the Questionnaire

The questionnaire is a powerful evaluation tool in behavioural sciences. If well designed, it can be a very reliable, veritable and optional tool:

(a) to complement facts emanating from either diagnosis and, or clinical findings;
(b) to validate the authenticity of a statement, findings for generalization etc.
(c) when rigorous experimentation cannot be adopted (i.e. Intervention studies are not needed).
(d) when information is needed from a large audience or participants to facilitate statistical analysis of results from opinion survey.
(e) to correlate performance and perhaps, satisfaction with a test system among different group of users especially if the questionnaire has sections on demographic questions about the participants.
(f) if the issues do not concern internal but external validity.
(g) necessary for testing hypotheses (statistical hunches) to establish the continuous relevance of a theory.
(h) To corroborate other findings.
(i) When both resources and time are inadequate.
(j) To protect the identity or privacy of the respondents (participants).

Although, a well designed questionnaire can be ascertained to posses clearly stated goal and purpose, it can either be the open-ended type and, or closed-ended questions.

The open-ended type of questionnaire:

As its name implies, the open-ended format constitute the unrestricted and sometimes endless views or opinions of a respondent or group of participants in a study expressed in the space provided in the questionnaire. The open-ended items are used when the researcher either wants the respondents to respond in their own words and, or when the research does not know all of the possible alternative responses. The open-format can additionally provide the researcher the opportunity for correcting an already ingrained beliefs in the respondents by way of intervention studies. In the open-ended questions, there are no predetermined set of responses and the participants are free to answer in what manner they chose. It easily provides a rich opportunity for wide variety of responses.

The closed-ended format:

The closed-ended items are used when there are a fixed number of alternative responses. In adopting this format, the respondents are asked to select an answer from among a list provided by the researcher (LoBiondo-Wood and Haber, 1990; Babbie, 1989). In survey studies especially, the closed-ended questions (or question-statements) are particularly popular because they provide a greater uniformity of responses and are also easily processed. Unlike the open-ended, the responses from survey utilizing the closed-ended questions are easily transferred directly into the computer format for analysis. The ease with which information from the closed-ended format are utilised facilitates the usage of the fixed response format called the Likert scale. Likert scales are lists of statements on which respondents indicate whether they "strongly agree" agree, "disagree", or strongly disagree". Structured, fixed-response items are favourably adopted when the question has a fixed number of responses and the participant (or respondent) is to choose the one closest to the right one. The closed-ended format has the advantage of simplifying the respondent's tasks as well as the researcher's analysis of results.

Examples of closed-ended and open-ended questions
Closed-ended (Likert-type scale)

A. As the current Dean of Faculty, how happy are you with your position?

1. Very happy
2. Moderately happy
3. Cannot say
4. Moderately unhappy
5. Very unhappy

B. To what extent do the following factors contribute to your current level of happiness?

		Not at all	Very Little	Somewhat	Moderate amount	A great deal
		1	2	3	4	5
1.	% of time available for leisure	1	2	3	4	5
2.	Personality type of H.O.D, and Lecturers	1	2	3	4	5
3.	% of time in administration	1	2	3	4	5
4.	% of time for PG faculty committee meetings	1	2	3	4	5
5.	Results of A & P for Academic staff members	1	2	3	4	5

Closed-ended:

A. On an average, how many abstracts of thesis for doctoral students does your faculty take to the Postgraduate School Executive Committee meetings?

(i) 1 to 3
(ii) 4 to 6
(iii) 7 to 9
(iv) 10 to 12
(v) 13 to 15
(vi) more than 15 including conversion cases
(vii) more than 15 excluding conversion cases

B. Would you characterize your achievement as:

(i) too bad
(ii) bad
(iii) about good
(iv) good
(v) excellent

Open-Ended:

A. "How would you describe the outcome of" each meeting at the PGS or Your faculty?

____

____

____

B. "What is your opinion about the former Head of State, Ibrahim Badamosi Babangida contesting the 2007 presidential election?"

____

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____

Pitfalls in Questionnaire Construction:

Whether the goal (objectives) of a well designed questionnaire is known and adequately stated or not, there are some obvious and non-easily avoidable pitfalls when it is used. Such pitfalls are usually the result of the type of format (i.e. open-ended and closed-ended) adopted in the construction of its items. Whenever the open-ended format is followed, the likely pitfalls of these are:

(i) the composition of the items which demand that the responses following them must be read individually may not be afterall.

(ii) there may be no easy way to automatically tabulate or perform statistical analysis on the items.

(iii) the interpretation of the items may demand some special skills which the researcher may not possess.

(iv) the item-response may be the subject of multiple interpretation as no two people will read and interpret any information the same way.

(v) both the time and money as well as other resources needed for its successful completion may be in inadequate supply.

(vi) the type of information expected by the researcher may be too tasking on the part of the respondents. If the item-statements are too loaded and many, the chances that several items may be returned unattended could be high.

(vii) interpretation can also be researcher's bias.

(viii) very irrelevant and incoherent responses can be provided by the respondents which may be outside the scope of the researchers' intention.

Pitfalls Using the Closed-Ended format

These include:

(i) Restriction in terms of the information that can be provided by the respondents on a particular subject-matter when the researcher structures the responses.

(ii) The researcher's failure to use another category labeled as "other (please specify…………..) in opinion survey.

(iii) the answer or response categories may not be mutually exclusive. In ensuring that answers are mutually exclusive, the researcher or investigator should carefully consider each combination of categories to avoid more than one answers. This can be effectively done by providing useful instruction to the question asking the respondent to select the one best answer.

Critical variables to questionnaire construction

Questionnaire design is a long process that demands careful attention. Though a questionnaire is only as good as the questions it contains, there are certain guidelines (otherwise, variables) that must be met before any questionnaire can be regarded as a sound research tool. Some of these are:

(i) Clarity: The major hurdle in questionnaire design is on how to make it clear and understandable to all. For any questionnaire to be relevant, it must be clear, succinct, and stated in an unambiguous manner. When items in a questionnaire are well stated, the aim is to eliminate the chance that the question will mean different things to different people. As part of clarity, colloquial or ethnic expressions that may not be equally understood by all the participants should be avoided.

(ii) Avoidance of double-barreled questions

(iii) Asking leading questions.

(iv) Short items rather than clumsy statements.

(v) Use of appropriate phrases.

(vi) Avoid embarrassing and hypothetical questions as well as biased items.

Questionnaire Construction Proper:

In considering the actual construction of the questionnaire, the following items may be important; and these are:

(i) **General questionnaire format:** Important in this format is the way question-items are spread out. Clustered question-items can be misleading and confusing both to the respondents and researcher during analysis and interpretation. Thus, as a general rule, the questionnaire should be spread out and it should be unclustered.

(ii) **Format for Respondents:** Several formats are notably available to which the respondents are expected to check in their responses. Using the brackets, the parentheses and the printing of a code number beside each response are considered appropriate. Some examples include the following:

<u>Four answer formats</u>

[ ] Yes	( ) Yes
[ ] No	( ) No
[ ] Don't know	( ) Don't know

Circling the answer		Tick (✓)	
1.	Yes	[ ]	Yes
(2)	No	[ ]	No
3.	Don't know	[ ]	Don't know

(i) **Contingency Questions:** These are question-statements that are conditional or responses that are dependent on previously determined item-statements. For instance, the intention to ask whether some respondents belong to a particular organization may elicit a question on how often they attend meetings, and whether they have held office in the organisation, and so forth. The subsequent questions in series are called contingency questions. There are several format for contingency question though the clearest and probably the most effective is:

A. Have you ever smoked marijuana?

[ ] Yes

[ ] No

B. If yes, about how many times have you smoked marijuana?

[ ] once

[ ] 2 to 5 times

[ ] 6 to 10 times

[ ] 11 to 20 times

[ ] more than 20 times

C. If no, why have you not smoked?

[ ] personal reason

[ ] parents as model

[ ] medical advice

[ ] friend's counsel

[ ] moral ground

It is equally important to note that contingency questions can be both complex and extensive, although, if well utilized in a survey, it can be a reliable source of information.

(iv) **Matrix Questions**

Whenever questions are asked and the same set of answer categories are provided, the format is the matrix question type. This is typically the case whenever the Likert response categories are used. In such instances, it is easy to construct a matrix of items and answers as indicated in the example below:

Beside each of the item-statements presented below, please indicate whether you Strongly Agree (SA), Agree (A), Disagree (D) Strongly Disagree (SD) or are Undecided (U).

		SA	A	D	SD	U
a.	What this country needs is more law and order.					
b.	Education from primary to tertiary level should be made free and compulsory.					
c.	Retirement age should be increased to 70 years for all category of workers.					
d.	A government that does not pay gratuity and pension should be sacked with immediate alacrity.					

This format has a number of advantages; some which are outlined already in the closed-ended format. First, it uses space efficiently. Second, respondents will probably find the method faster to complete as a set of questions presented in this fashion. Third, it may also increase the comparability of responses given to different questions for the respondents as well as the researcher.

(v) **Ordering questions in a questionnaire:**

The order in which questions are placed or asked in a questionnaire can also affect the type of answers to be given. First, the appearance of one question can affect the answers given to later ones. For instance, if a number of questions have been asked about the dangers or likely problems of electing into office, Ibrahim Babangida in 2007 to Nigeria politics; then a question asks respondents to volunteer (open-ended) what they believe would happen to Nigeria. Usually it is preferable to ask the open-ended question first.

To overcome the difficulty and confusion following the ordering of questions, some researchers do in a futile manner adopt the random setting of questions. Since adopting this method may both be confusing to researchers and respondents, the safest solution is sensitivity to the problem (Babbie, 1989). Even though the issue of question order is important and should not be ignored, knowing the number of stems expected in a question is of equal importance while a sequential planning and arrangement is suggested. If the order of question is really of utmost importance in a study, the suggestion is that more than one version of the questionnaire containing different possible ordering of questions may be constructed. The possible effect can then be known if it had to be ignored. Whatever the case, it is however important that the questionnaire is pretested in their different forms.

The desired ordering of questions also differs somewhat between self-administered questionnaires and interviews however. For the self-administered questionnaire, and which is the focus of this section, it is usually suggested that the questionnaire should begin with the most interesting set of questions. This is very important as some potential respondents who glance casually over the first few questions would have their interest sustained and should want to answer them. To do this adequately well, the section should reflect on question-items that do not threaten the privacy of the respondent nor are embarrassing to them. Somehow, it may be nice to also reflect such request for demographic data (e.g. age, sex, number of children etc) at the end of the self-administered questionnaire to avoid the stereotype of a routine format. However, for the interview surveys the ordering format is definitely different.

(vi) **Instructions**

To retain the utilitarian value of a questionnaire, such questionnaire must have or contain adequate instructions to direct the respondents on the way and manner it is to be completed. The instructions must be provided in clear unambiguous statements and may be followed, with some introductory comments about the purpose of the questionnaire. Such basic instructions as "please kindly indicate yours answers to the underlisted question-statement by placing a check mark or an X in the box beside the appropriate answer or by writing or using a thick ([) in the respective columns" will be a very useful guide to the respondents. Short and simple introductory remarks and instructions help make sense out of the questionnaire by allowing it to be less- chaotic and cumbersome, especially when it taps a variety of data. The respondents are also put in their correct frame of mind for answering the questions. This method also allows the research to code his data adequately for analysis while it reduces the possibility of unrequested response. In consequence, the provision of sufficient instructions cannot be enough if the intended desired results is to be achieved. It is important to also sound a note of warming that the sections and sub-sections with atypical intent should also be given adequate instructions. Such can be the case where the respondents are asked to rank-order their responses. Such instruction should indicate how many answers are to be ranked and by what means (e.g. ranking from 1 to 10) with the first, indicating the highest possible value and so forth.

(vii) **Item Coding**

If question-statements will make any meaning in a questionnaire, items in the scale must be adequately and systematically entered. The item coding is a systematic way of entering items (or stems in a questionnaire) for easy identification particularly for computation. It involves the use of symbols, character, letters or simply numbers. It facilitates easy retrieval of information for analysis, interpretation and application for making meaningful statistical decisions following a survey.

One caution however is to avoid the use of over-vexed coding systems where symbols and item character are indiscriminately used as this can lead to double-entry and confusion.

(viii) **Questionnaire spreadsheet**

Irrespective of the question-ordering pattern in a given questionnaire, the spreadsheet facilitates the ease by which required information are got from the respondents. Questionnaire spreadsheet, also possibly known as worksheet, is a special appendage necessary for information retrieval or response-entry to cater for very complex aspect of the questionnaire. The spreadsheet is usually designed to have both rows and columns and takes the patience of a respondent to adequately provide and enter his/her information appropriately. In the example below, the respondents were required to supply information on pupils by class and by type of seat in Early Child Development Centres (ECDC).

A. **Pupil furniture by class by Type of Seat (ECDC)**

Number available per type of furniture				Children sittings on floor or Desk	
Class	Single Seater	Two Seaters	Three Seaters	Number of pupils sitting on desks	Number of girls sitting on floor
				M	F
KG1					
KG2					
NS1					
NS2					

Taking the illustrated table above, the type of information supply would be most difficult if there is no questionnaire spreadsheet and a concomitant instruction on the way and manner by which the information is to be supplied. Additionally, the fact that each of the forms (e.g. KG1, KG2 etc) may also run in streams, makes the task a complex one. For instance, the information required for KG1 may have to be split along KG1 (ABCDE) as the case may be; and it is the same format for KG2, NS1 and NS2 respectively.

In making the task of the respondent less cumbersome, a spreadsheet is necessarily attached with some instructions. See the example below.

Class/streams	Number Available Per Type of Furniture			Children sitting on Floor or Desk		
				Number of pupils sitting on desks		Number of girls sitting on floor
	Single Seater	Two Seater	Three Seater	Males	Females	
KG1 A						
B						
C						
D						
E						
Total →						
KG2 A						
B						
C						
D						
E						
Total →						
NS1 A						
B						
C						
D						
E						
Total →						
NS2 A						
B						
C						
D						
E						
Total →						

The spreadsheet in a questionnaire assists the respondent to know the type and extent of information needed which he then happily supplies. Researchers also find it very interesting to retrieve, code and analyze information (data) from such mechanism with utmost equanimity.

Pre-testing of the Questionnaire

Pre-testing of research measure or scale (otherwise inventories) that are either recently designed or that, they have been designed for quite sometime, is a common phenomenon in especially psychological research. In pre-testing, the designed scale (or questionnaire) is pilot-tested to establish its utility when the psychometric properties (i.e. validity and reliability coefficient values) are known. Though the section on adequate psychometry for research instrument is considered elsewhere, it is important to state however that the pre-testing of a research questionnaire is more of exploratory than actual evaluation. It easily allows the researcher to know the thoroughness in the mix of items composition, their discriminatory ability and sometimes, depending on the type of questionnaire designed, its difficulty level. During pre-testing, items may be re-constructed, deleted and, or re-organised (re-structured) depending on experts judgements.

One particular feature of the pilot-testing however, is that a small group of participants (or individuals) are used who may have similar characteristics to those of the participants (or individuals) who will be used in the main study. At the pre-testing stage, the researcher is able to ascertain the trend in the response to items, and whether the respondents understood the items, and additionally to know the amount of time it may take to respond to the questionnaire (or scale). To achieve the utmost success in questionnaire construction and administration, it is expected that the researcher should ideally be trained to saturation before the main study commences. This is important if training effects likely to contaminate the main study is to be limited and, or taken care of. It should give the opportunity to know whether tasks are sufficiently sensitive to discriminate among subjects and of course measurement properties (i.e. whether reliable).

Without doubt, the feedback from pilot work and, or pretest stage can also inform the researcher on the type and choice of statistics necessary for computation. The type of statistics and their rationale in analysing the questionnaire data is taken up in another section.

9

STATISTICAL ANALYSIS AND INFERENCES

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INTRODUCTION

Statistics is a vital tool in any research. Its use starts from the point of gathering data, through data analysis to the point of making the final decision or inferences. The aim of this chapter is to take us through these different stages in the use of statistics in research methods and the ultimate objective is to optimize the gains of statistical analysis. These gains are achievable through minimization of errors, correct method of data analysis and reasonable interpretation of results. It is assumed that the reader has had some basic training in the fundamentals of statistics as most terms and concepts are not explained in detail.

DATA GATHERING

The two common means of gathering data for a research purpose are routine collection from a source and data generation through surveys and experiments. Data abstracted from a source are called *secondary data* as the researchers are usually not responsible for the original design and collection of the data. The data generation processes in such cases are usually established for specific purposes not necessarily for the purpose for which the investigator or researcher intends to use the data. But since the information is available and relevant to the study objectives of the researcher, it is cheaper to collect data from a source like this. Historians and social scientists will find this source profitable. Sometimes a desktop review of available information may be sufficient for a needs assessment to plan a programme. For example, a researcher interested in correlating weather conditions with some events will do well to collect weather parameters from the meteorological services. In medicine, such routine sources include the census, vital registration systems, institutions such as health facilities, schools or armed forces, and disease notification systems such as the cancer registries. Unfortunately, the data from these routine sources suffer from the problems of timeliness, relevance, incompleteness, and inaccuracies.

The second source of data is surveys or experiments. These are planned studies to collect information relevant to specific objectives, including testing of specific hypothesis. The students from the Humanities and the Social Sciences. Public Health, Law and Education are most likely to be involved in carrying out surveys while students of Agriculture, Physical and Biological Sciences, Basic Medical sciences, Veterinary Medicine, Pharmacy and Clinical Medicine are most likely to be involved in conducting experiments.

Another important consideration is the type of research methods which could be either qualitative or quantitative. But since the majority of students will be involved with quantitative research, our major focus will be on guidelines for the analysis of data from this type of research. Regardless of the type of data gathering mechanism, the source yields a primary data. In subsequent sections, the analysis of data from qualitative research shall be discussed.

DATA MANAGEMENT

Data management starts from the onset of data collection. There is no amount of statistical treatment that can completely rectify a badly collected data to make it useful. If for example, certain key variables relevant to the study objectives are not included in the data collected, there is no amount of data imputation or any statistical manipulation that can make the results of analysis adequate and reliable. Also, an error introduced at the data collection stage will propagate through the entire data management process. This may lead to a false inference. It is therefore important to:

- check on the instruments for data collection for completeness of relevant variables to the study objectives;
- ensure adequate training of interviewers or data collectors;
- if necessary, appoint supervisors to monitor data collection;
- monitor completeness and accuracy of data collected and correct any error at the point of data collection.

The best way to do this is to check data collected on a daily basis for immediate detection of errors and corrections. Even when data is collected from routine sources, the researcher needs to check the data for missing values or copying errors. One should ensure that the available relevant data is correctly abstracted from the existing records.

Another step is for the student to decide on the mode of data analysis. This can be either manual calculations or with the aid of the computer. Students are advised to take the advantage of computer technology and use the numerous computer analysis packages which are now available. The computer approach does not only ensure the accuracy of the statistics derived from the data, its results are faster and more comprehensive than the best manual computation method.

DATA CODING/COMPILATION

The first step in the preparation of data for statistical analysis is coding of variables and compilation of records. Coding is the translation of responses to items of information on the questionnaires or data collection sheets to specific categories for the purpose of analysis. This involves the assignment of numbers to the various levels of the variables under consideration. For pre-coded questionnaires, the load of work here is light but certainly important and tedious for open-ended questions. For example, the variable *gender* may be coded with the assignment of 1 to *males* and 0 to *females* while abilities of students to perform certain educational tasks rated as *Low, Medium* and *High* Abilities may be assigned numeric codes 1, 2, and 3, respectively. Coding can also mean the analysis of factual response data particularly in qualitative research and the subsequent assignment of individuals to classes or categories, or the assigning of categories to individuals.

DATA CLEANING/EDITING

As earlier mentioned, data cleaning should start right from the stage of data collection, when students are advised to go through each record of data collected on a daily basis. The measurement and interview errors, inconsistencies, and inaccuracy of information can be detected at this stage. The checks are also for missing values, copying errors such as writing '80' instead of '18'. Most data sets contain one type of error or the other. After data entry into the computer or into any similar device in readiness for analysis, the data should be appropriately cleaned of a number of errors. Wrong conclusions can be drawn from any data, just because errors have not been checked for and removed from the primary data. This will defeat the aim of the research. Any amount of time spent to ensure that the right image of the data is analysed is therefore justified. Often, once a clean data set is achieved, the analysis itself is quite straightforward and fast, compensating for the time spent in data cleaning. Data Cleaning is a two-step process including detection and then correction of errors in the data set.

Common sources of error during data entry include:

- missing data which have been coded as "999"
- 'not applicable' or 'blank' which have been coded as "0"
- typing errors during data entry
- column shift in which data for one column are entered under the adjacent column
- fabricated or contrived data deliberately introduced
- coding errors

DETECTION OF ERRORS IN DATA SETS

Descriptive Statistics

The calculations in some descriptive statistics can lead to the detection of some types of errors in a data set. Such statistics include frequency counts, missing cases, minimum and maximum values as well as means, medians, mode, range and standard deviations. With their calculations, one will be able to detect some extreme or impossible values. If for example we assign *male = 1and female = 2* in a data set involving gender distribution, the presence of 3 and 4 in the data set will imply error in coding or in data entry. Also, if the standard deviation is higher than the mean value, then some impossible extreme values or outliers must have been included in the data set. When these are fished out and corrected, the standard deviation will become smaller. The following are a few of the ways by which errors can be fished out.

Graphs

Scatter plots. One other way to inspect the data for errors is to plot one set of variables against another on a simple x – y graph. This may reveal the relationship between the two sets of variables under consideration. If one takes a close look at the general trend, one may see some points that do not conform to the general trend. Such points may need rechecking. Plotting the scatter plots will show the outliers, that is, points which do not follow the general pattern of association between the two sets of variables.

Histograms. A histogram is the graphical display of frequency distribution in form of rectangular bars whose heights represent the frequencies of the data intervals represented by their widths. A histogram can also reveal extreme values in a data set by showing values which are not within the range of the distribution, especially when normal distribution is assumed. If the data set is small, i.e. less than 100 cases and 10 variables, cleaning can be done once and for all. However, the process is done in several stages for a large data set. It begins with the examination and correction of the key and important independent variables (e.g. treatment, gender and age). Other variables may be cleaned as each of them become relevant in the analysis. The most important thing is never to introduce new variables into an analysis without first checking for errors and making corrections.

DATA ANALYSIS

Statistical quantities employed in data analyses are used for either descriptive purposes or for drawing of inferences or both. Although there are some special statistical methods for some specific data situations and statistical questions, there are some common standard statistical procedures which cut across all disciplines. These procedures are useful for carrying out univariate analysis, bivariate analysis or multivariate analysis. The following are the initial steps basic to all statistical analyses of data:

- Identify items of information relevant to the study objectives.
- Identify independent or explanatory variables.
- Identify response or dependent variables.
- Identify variables to be derived from other variables.

The computer approach is most favoured for data analysis; but in doing this, the researcher should check on the following concerns:

- Is data qualitative or quantitative?
- Is data already in computer format?
- Any need for post coding of data?
- Which statistical package will be used for database creation?
- Any need to consult a statistician or expert on the subject?

As a general rule, the type of data analysis to carry out depends on the following:

- Study objectives
- Type of data
- Design of study - any effort to reduce variability in sets of data or minimize errors
- Nature of samples - independent or dependent
- Sample size

General format of statistical analysis of data

Statistics is used specifically to

- reduce a large quantity of data to a manageable size,
- present data in understandable form,

- aid in the study of populations,
- aid in decision making, and
- aid in making reliable inferences from observed data.

The following are necessary common activities as first steps in the statistical analysis of quantitative data:

- Make frequency distribution tables for all variables.
- Compute appropriate descriptive statistics.
- Make necessary cross-tabulations dictated by study objectives.
- If comparing or looking for associations among variables, plot data in a scatter diagram and apply the appropriate test statistic to determine strength of association.
- Choose appropriate statistical tests to use, which could be either parametric or non-parametric. The choice of which to use is indicated by how much the data available satisfies the assumptions underlying the developments of the statistical tests.

As indicated in earlier sections the first activities in data analysis are as follows:

- Prepare a coding format (for example if the statistical package-Epi-Info is to be used, there is the need to design the data entry questionnaire).
- Post code all open questions.
- Ensure all variables are coded appropriately.
- Prepare dummy tables.
- Start data entry.

Nature of Statistical Analysis

The nature of statistical analysis depends on the research questions which dictate the study objectives in the first instance and which inform the type of data collected. The usual objectives of most studies arise from the need

- to estimate certain population parameters,
- to compare attributes of data in many groups,
- to determine the best treatments or interventions to produce certain results,
- to find relationships between variables to explain ob-

served effects, and/or to predict future events from observed data.

The researcher should be able to identify the extent of statistics required for data analysis. He should also know if his study will only need descriptive statistics or will require statistics to test a certain hypothesis and therefore draw appropriate inferences from the data. It is not every statistical work that requires a test of hypothesis or that must contain P-values or some of the statistical tests of significance as erroneously believed by some researchers. Such researchers, who are often graduate students driven by the desire to impress the examiners, usually carry out intervention studies even at the expense of available resources such as time, finance and manpower. This notion is not correct. Researchers should know that statistics is only a means and not the end in itself. The research objective should dictate the extent of statistical analysis required.

Common Statistical Procedures

Descriptive Statistics

These include frequency counts, minimum and maximum values as well as measures of central tendency such as the means, medians, mode, range and measures of dispersion such as standard deviations. Other statistics are ratio, proportion, percentages and rates.

Use of Graphs or diagrams

For evocative displays of data to draw attention to the salient features and patterns in the values, graphs and diagrams are used to summarize and present data. These graphs or diagrams include scatter diagrams, histograms, pie charts, bar charts, pictograms and line graphs. Some of these displays such as scatter plots and histograms may as previously discussed, reveal certain features that may suggest the need for cleaning of data before further statistical analyses. The choice of appropriate descriptive statistics, graphs or diagrams depends on the types of data collected and the objective of the study.

TYPES OF DATA

Let us quickly remind ourselves of the two types of data available. These are qualitative and quantitative data.

Qualitative Data

Qualitative data arise when the observation fall into separate distinct categories with no notion of numerical magnitude. Such data are measured on the nominal or ordinal scales. Recall that nominal scales are mainly classificatory and there is no natural order between the categories which are also mutually exclusive, as no individual can belong to more than one category. Such data are inherently *discrete*, in that there is a finite number of possible categories into which each *observation* may fall. Examples include:

- Colour of eyes: blue, green, brown and white;
- Examination result: pass or fail;
- Type of medical diagnosis: Hypertension, diabetes mellitus, cancer of the breast, HIV infections, asthma, tuberculosis and irritable bowel syndrome;
- Gender: Male, Female.

In the ordinal scale of measurements, an ordering exists as the mutually exclusive categories are graded. It is sometimes referred to as ranking scale. Examples include:

- Level of Educational Qualification: Teachers Grade II certificate, NCE, B.Ed. or B.A., Masters, and PhD degrees;
- Socio-economic status: low, middle or high; Level of pain: mild, moderate, severe.

Data collected on these scales are referred to as categorical data.

Quantitative Data

This type of data has the notion of numerical magnitude. In other words, the values are expressed in numbers and in some cases the units of measurements are well known. They have all the properties of nominal and ordinal scales but are measured on at least the interval scale. In the interval scale of measurement, the zero level is always arbitrary but the differences between successive points are equal. That is, the difference between 80% and 81% is the same as the difference between 81% and 82%.· Examples are: Students' scores in a school examination and "Temperatures of patients measured on either Celsius or Fahrenheit units". The scale has both numerical magnitude, direction (interval) and an absolute or true zero. For example, height, weight, and age all have absolute zeros regardless of their units of measurements. For example, zero centimetre equals zero feet if height is measured on either unit.

The data on these scales of measurements are said to be discrete if the measurements are integers assuming only whole numbers or counts. Examples are the number of students in a class, parity, and apgar score. They are continuous if the measurements can take on any value, usually within some range in a continuum. For example, students' score in a Biology test is a discrete variable while weight and skin fold thickness are continuous variables.

TYPES OF ANALYSIS

Univariate Analysis

This is when each variable is examined at a time in the analysis to examine the distribution of values of each set of variables. This task is also called data exploration. The statistics appropriate in this situation is to provide precise descriptive analysis and to make frequency distribution tables for all variables.

Frequency distributions

These are used basically to describe a given set of data according to the number of times a value or a data interval occurs in the data set. They can also be used to test whether two or more distributors are sufficiently similar to warrant merging them. For instance, if one is studying the performance of boys and girls in English Language, distribution of the scores of boys and girls may be similar. If this is so, the data for boys and girls can be merged for analysis.

Graphs
Graphs are two-dimensional representations of relations between pairs of variables. If a relation or interaction exists in a set of data, a graph will show it as well as define its nature. The types of relationship between two variables include linear, quadratic exponential, etc.

Descriptive Statistics
Descriptive Statistics include measures of central tendency as well as measures of variability or dispersion. The three common quantities for measuring average or central tendencies or location are the *mean, median* and *mode*. They tell what the data 'look like' on the average. The *mean* is the most important measure of central tendency, and the most widely used in research. However, the *median* (the value in the middle when the data is arranged in an increasing or decreasing order) and the *mode* (the mostly occurring value in a set of data) can sometimes be useful in some data situations. In particular, the median is more appropriate than the mean for graded responses or quantitative data having skewed distributions. For example, the *median* is used as a cut-off point or mark to rank subjects on a set of scores in categories or classes e.g. high and low abilities.

On the other hand, the measures of variability include the range, variance and standard deviation. They are very important because adequate interpretation of data is virtually impossible without a good knowledge of the variability in the data, as measured by the standard derivation. In fact, means as summary indices are not usually reported without the standard deviations. And when one reports the median as a measure of average, one should also report the range.

Bivariate Analysis
This is indicated when one is interested in examining the relationship between two variables simultaneously. One set of variables is termed dependent variable and the other, independent variables. Such analysis can be used to compare two groups of data based on certain indicator variables and in each case test certain hypothesis. In particular, the interest may be to look for the effect of certain treatments on some

physiological and biochemical parameters. Among other possibilities, the bivariate system of analysis can examine the effect of certain teaching methods on the performance of students at an examination or find out the effect of two different fertilizers on the yield of certain agricultural crops. The rationale behind this kind of analysis is to allow us take decisions. Thus, it is important to note the procedures for testing hypothesis.

Tests of Significance

A test of significance is a statistical test that attempts to determine whether or not an observed difference indicates that the given characteristics of two or more groups are the same or different; or whether a relationship exists between two or more variables. The procedure for investigating the truth of any hypothesis is called hypothesis testing and there are six steps by which the tests are accomplished.

Step 1. State the Null Hypothesis

The hypothesis is stated in a form that it would be nullified if available data do not support it. If it were to compare the difference in means between two groups, the null hypothesis will be stated as: There is no difference between the means of the two groups. If the problem were to test for associations, then the null hypothesis will assume that there is no association between the categorical variables. In a study to determine the effect of a drug suxamethonium on serum potassium levels, the null hypothesis is: the drug suxamethonium has no effect on the serum potassium levels. It is clear that we are always testing the null hypothesis and we only calculate the probability of observing a value as extreme or as more extreme than observed for our test statistics if the null hypothesis were true.

Step 2: State the Alternative Hypothesis

This is usually the research question and it is the hypothesis to fall back on whenever the null hypothesis is rejected. This can be stated either in one direction to yield a one-tail test if one is sure of the direction, or in a two-way direction to yield a two-tail test. For example, the alternative hypothesis to the one stated above is, can the drug suxamethonium have an effect on the serum potassium levels?

Step 3: Set the criterion for rejection

How different must the means be before we can say the mean of group A is not the same as that of group B? Or how big must the effect be before we can say that it is significant or not significant? The probability of wrongful rejection of the null hypothesis should be very small. By convention, a probability of 5% is chosen. This implies that there is only a 5% chance or less that the mean of group A is similar to the mean of group B. This 5% describes the area of the unit normal curve with 2.5% on the right and 2.5% on the left sides of the curve. The level is called level of significance or the alpha (á) level. Although 5% is very common, we can set á level to more stringent values such as 0.001, 0.01 or less stringent values such as 0.10 or more.

These values correspond to the probability of observing such an extreme value corresponding to the standard normal deviate by chance. Another interpretation of the significance level á, based on decision theory, is that á corresponds to the value for which one chooses to reject or accept the null hypothesis H_o.

Step 4: Choose appropriate test statistics

Recall that you are at liberty to use a parametric or non-parametric test statistic according to whether you are assuming an underlying distribution for your data or using a distribution-free method. The relevant parametric test statistics for comparing two mean values is the student t-test, if the two groups are independent; otherwise it is the paired t-test if groups are dependent. If your data do not satisfy the assumptions underlying the use of this test statistics, then a non-parametric equivalent is the Mann-Whitney-U test if the groups are independent or the Wilcoxon-rank sum test if dependent.

Step 5: Evaluate the test statistics

Although this can be done manually for a small data set, the use of the computer is recommended for reasons stated earlier. Indeed there are many statistical packages that are available for calculating virtually all the test statistics depending on the problems.

Step 6: Conclusions and drawing of inferences

This last step in the test of hypothesis entails drawing appropriate conclusions from the observed data and taking decisions. Recall that the p-value or á- level of error is the probability of observing a calculated value of the test statistic or an extreme value if the null hypothesis were true. These p-values or á- level of errors can be obtained from appropriate statistical tables to test the statistics used. For example, there is a table for t-distribution from where the approp riate level of error can be obtained if the student t-test has been used. Recall that the student t-test is appropriate for comparing two mean values. The decision rule is based on the á- level error. If the value of t from the table at the chosen á- level error is smaller than the calculated value in step 5 above, we reject the null hypothesis and take the alternative hypothesis. It is very common to choose á- level of 5% even though other levels can be chosen. Then we say if $p<0.05$, we reject the null hypothesis and conclude that our data do not support the null hypothesis.

One common problem is to generalize our result beyond the sample data. There are a lot of considerations before gene-ra-lizing results beyond the study sample. You may need to check how representative of the target population your data is. How big are your sampling errors? How well have you taken care of confounding factors. Can you strictly attribute observed treatment effects to the treatments only? In other words, a lot of caution is necessary when interpreting findings. As much as possible, make sure to write the report in the context of the problem.

SOME OTHER STATISTICAL TESTS

Let us now describe the most commonly used statistical tests for measuring the strength of association between two variables or comparison of two groups in detail.

Test of Association

It may be the objective of the study to examine the association between two variables. The strength and weaknesses of this association could be very important as one of the steps to determine causal relationship. As mentioned, the type of data is one of the factors that will determine the type of statistical analysis and test statistics.

Qualitative Variables and the Contingency Table

The values of qualitative variables are attributes which merely define the categories of interest. These attributes are mutually exclusive and each individual subject can only belong to one category of the variables. In examining the association between any two categorical variables, each subject is allocated to corresponding categories. The resultant cross-tabulation yields contingency tables whose size is dictated by the number of categories of each variable. Note that the entries in each cell of the tables are numbers and the contingency table consists of a number of rows and columns. The smallest contingency table is a 2×2 contingency table in which each variable has only two values and the contingency table yields two rows and two columns.

Example

The interest of the researcher may be to find out the association between survival rate and the type of treatment given for a particular health condition. The patients are divided into two groups; group A was given streptomycin as well as bed rest and the other group B placed on bed rest only. The results showed that 4 out of 55 patients in group A died before 6 months period while 14 out of 52 in group B died during same period.

Question: Is there any significant association between treatment received and survival?

	Outcome of Treatment		
Treatment	**Death**	**Survival**	**Total**
Group A	4 (9.25)	51 (45.75)	55
Group B	14 (8.75)	38 (43.25)	52
Total	18	89	107

Two contingency tables have been combined above. One is from the observed data given while the other is calculated based on the null hypothesis that there is no difference between the two methods of treatment. The data for the calculated is given in parentheses in each cell. The statistical test to be carried out involves comparing the calculated value of $\div^2$ (Chi-square) based on the difference between the two contingency tables with the value of $\div^2$ read from the table at á = 5% and (r-1)(c -1) = 1 degree of freedom. The calculated $\div^2$ is based on the following definition:

$$\chi^2 = \frac{\sum (O_i - E_i)^2}{E_i} = \frac{(4-9.25)^2}{9.25} + \frac{(14-8.75)^2}{8.75} + \frac{(51-46.75)^2}{46.75} + \frac{(38-43.5)^2}{43.5} = 7.37$$

where O_i is the observed frequency in the i[th] cell of the contingency table and E_i is the expected frequency given that the Null Hypothesis is true. The expected value under the null hypothesis that "there is no association between type of treatment and outcome of treatment" is given in brackets in the table. The value of $\div^2$ from the table at 1 degree of freedom at 5% level is 3.841, which is far less than the calculated value of 7.37. Therefore we conclude that there is a statistically significant association between type of treatment and outcome of treatment ($P<0.05$). A look at the data shows that the survival rate is better in the group given streptomycin in addition to bed rest.

Yate's correction for continuity

When we have a 2 × 2 contingency table as we have above, we should make some corrections to allow for the discrepancy in approximating a discrete sampling distribution with a continuous distribution. This correction is accomplished by subtracting ½ from the absolute difference between the observed and expected frequencies. That is:

$$\chi^2 = \frac{\sum(|O_i - E_i| - \frac{1}{2})^2}{E_i}$$

The quantityis $\frac{1}{2}$ Yate's correction for continuity. The researcher can try and find the corrected value of $\div^2$ in the above example.

Paired Samples

One of the criteria to consider in the choice of a test statistic is the design of the study. We check whether the samples are dependent or independent. Recall that to ensure comparability of groups, one way is to match groups on important variables and we only attribute any differences to the interventions. Sometimes, the same subjects are exposed twice and the differences are measured. An example will make this clearer and we now consider qualitative variables.

Example

A retrospective study was done to find out if certain strains of influenza could be teratogenic when infection occurs during the first trimester of pregnancy. Each of 229 women who had defective babies following an influenza epidemic was matched with a control among those who had normal babies following the epidemic. The data from this design revealed that there are four different types of women. The result is as follows:

Type of Pairs	Women with defective babies	Women with no defective babies	Number of pairs of women
1	+ve influenza	+ve influenza	80
2	+ve influenza	-ve influenza	40
3	-ve influenza	+ve influenza	63
4	-ve influenza	-ve influenza	46

This data can also be presented in a 2 × 2 contingency table as shown below

	Influenza +	influenza -	
Birth +	80®	63(s)	143
Defect -	40(t)	46(u)	86
	120	109	229

Using Mc –Nemers' Test statistics: $X^2 = \frac{(s-t)^2}{s+t} = \frac{(63-40)}{63-40} =$

P<0.05

Conclusion
The babies without birth defects appear more likely to be free from influenza. You may need to consult appropriate Statistics textbooks for details of the statistical methods chosen.

Further use of the Chi-Square Test
Goodness of Fit Test
Often, we may need to compare an observed frequency distribution with the expected distribution from a theoretical model. We may also want to test an observed frequency distribution against a known population frequency. The statistical procedure of test of goodness of fit using ÷² test becomes very useful in doing this.

Example
Gastric Cancer is postulated to occur more often in persons with Type A blood. Suppose 200 patients with gastric cancer have the following percent of blood type: O(38%) A(52%), B(1%) AB (3%) and suppose it is established in the general population that the percents of AOB groups are: O(45%), A(40%), B(12%) and AB(3%).

Question: Is there a statistically significant difference between the blood type frequencies in the sample and in those existing in the general population?

	Blood Groups				
	O	A	B	AB	Total
Observed Frequency	76	104	16	4	200
Expected Frequency	90	80	24	6	200

$$\chi^2 = \frac{\sum (O_i - E_i)^2}{E_i} = \frac{(76-90)^2}{90} + \frac{(104-80)^2}{80} + \frac{(16-24)^2}{24} + \frac{(2-6)^2}{6} = 1271$$

The value of $\div^2$ from the table at í = n − 2 = 2 degrees of freedom at 5% level is 5.99, which is far less than the calculated value of 12.71. The conclusion here is that there appears to be a statistically significant difference between the distribution of blood types among patients with gastric cancer and the distribution in the general population.

Fisher's Exact Test

This is applicable in a data situation when there are extremely low frequencies in a 2 × 2 contingency table and one is in doubt as to the adequacy of continuity correction. In this case, it will be necessary to calculate the probability of observing the figures in the cells conditional on the marginal totals.

Example

Efficacy of Anti spasmodic drug in controlling seizures

	Seizure Status		
	+ ve	ve	Total
Drug	2 (a)	6(b)	8 (a+b)
Placebo	7 (c)	1 (d)	8 (c+d)
Total	9 (a+c)	7 (b+d)	16 (n)

$$P = \frac{(a+b)!\ (c+d)!\ (b+d)!\ (a+c)!}{n!\ \ a!\ \ b!\ \ c!\ \ d!}$$

$$P = \frac{8!\ 8!\ 9!\ 7!}{16!\ 2!\ 1!\ 6!\ 7!} = 0.020$$

REGRESSION ANALYSIS

If the researcher's interest is to determine the relationship between variables in terms of magnitude and direction, a regression analysis or correlation analysis is carried in the case that the data are quantitative. When the objective is to explain one variable from the knowledge of the other for purposes of prediction, the regression model is always fitted to the data. But if it is to determine the strength of relationship between the variables, the correlation coefficients are calculated. Again, the choice of test statistics to determine the strength of association or relationship between the variables depends on the kind of data and this will suggest the use of either parametric or non-parametric statistics. Thus, the product-moment coefficient of correlation (r) or the Spearman rank-order correlation coefficient (r_s) may be calculated as a measure of relationship. The value of the coefficient lies between -1 and +1 and the student t-test can be used to assess its statistical significance. Please note that when only two variables are involved, the product-moment correlation coefficient is mostly used provided the data set satisfies the assumptions underlying the use of a parametric test.

Some Uses of Regression Analysis

1. To learn if Y, the dependent variable, does depend on X, the independent variable;
2. To predict Y from X;
3. To determine the shape of the regression curve;
4. To determine error in Y in an experiment after adjustments have been made for the effect of a related variable X;
5. To test a theory about cause and effect.

Steps in Regression Analysis

Regression analysis is performed on populations with bivariate distributions i.e. distributions in which the variables are associated in pairs. That is, for every measurement of a variable X, there is a corresponding value of a second variable Y. The variable from whose values predictions are to be made is denoted by X and variable whose values are to be estimated or predicted is denoted by Y.

1. The first step in regression analysis is to represent the n pairs of values of X and Y as n points on a graph to obtain what is commonly referred to as a scatter diagram. The independent variable X is plotted along the horizontal axis while the dependent variable, Y is plotted along the vertical axis.

2. A straight line, the line of "best fit" is drawn connecting as many points as possible on the scatter diagram. This line is called the sample regression of Y on X. Its position is fixed by two results:
   (i) It passes through the point O ($\bar{X}$, $\bar{Y}$), the point determined by
   (ii) the mean of each sample.
   (iii) Its slope is equal to b in the unit of Y per unit of X, where b is the coefficient of X in the regression equation..

Now, the equation of any non-vertical line can be written in the form: $Y = a + bX$ where a is the intercept on Y-axis and b the slope of the line. A particular line, therefore, is completely determined if the values of the constants a and b in its equation are known. Therefore, in order to find the line of best fit to a scatter diagram of n points, we must determine a and b in such a way that the n points lie as close to the line as possible. After the equation of the line of best fit has been determined, it will yield for each X-value a certain Y-value, which will be an estimate of the actual Y-value. The equation of the line of best fit can therefore be written in the form

$Ye = a + bX$ where Ye is the estimated value obtained from the line and Y is the actual value obtained by measurement.

Example

The age X in weeks and mean height Y in centimetres, of cowpea plants are given in the following table. Find the equation of the line of regression of Y on X. Calculate the standard error of estimate for the regression.

X	Y	XY	X^2	Y^2	Y_e	$Y-Y_e$	$(Y-Y_e)^2$
1	5.5	5.5	1	30.25	-0.52	4.98	24.800
2	6.8	13.6	4	46.24	13.19	-6.39	40.800
3	25.0	75.0	9	625.0	26.9	-1.9	3.61
4	40.0	160.0	16	1600	40.61	-0.61	0.372
5	55.0	275.0	25	3025	54.32	0.68	0.462
6	72.0	432.0	36	5184	68.03	3.97	15.761
7	80.0	560.0	49	6400	81.74	-1.74	3.028
28	284.3	1521.1	140	16910.49			88.865

The mean $\bar{X}$ = 4 while the mean $\bar{Y}$ = 40.614. The regression equation Y = a + bX

$$b=\frac{\sum XY-\bar{X}\bar{Y}}{\sum X^2-n\bar{X}} = \frac{1521.1-7(4\times 40.614)}{140-7\times 16} = 13.71$$

$$a=\bar{Y}-b\bar{X}=40.60-(13.37\times 4)=-14.23$$

That is, the equation of the regression line is therefore $Y = -14.23 + 13.71X$

Standard error S_e of estimate for the regression n calculated is given by:

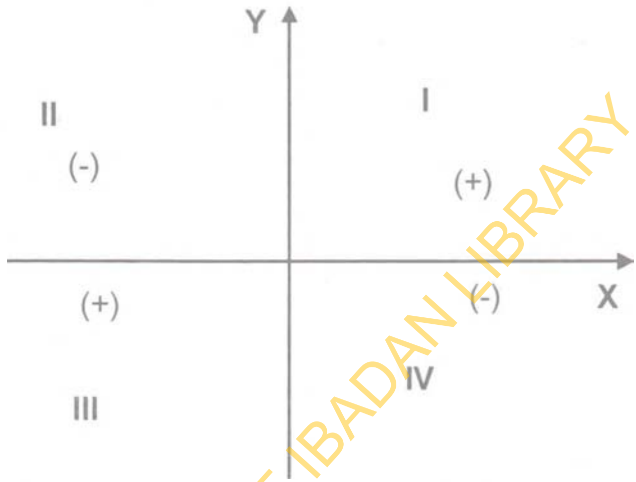
$$S_e^2=\frac{\sum (Y-Y_e)^2}{n}$$

where Y_e is the predicted value of Y from the regression equation. That is,

$$S_e=\sqrt{\frac{88.865}{7}}=3.56$$

CORRELATION ANALYSIS

Correlation coefficient is another measure of the mutual relationship between two variables. Correlation coefficient denoted by r is a quantitative expression of the strength of the linear relationship between two variables. The relationship between the variables X and Y can be determined from a sample of n pairs and the first step is the construction of the scatter diagram for the data to illustrate the existence and the nature of a relationship. The figure below shows the signs of the cross products, XY in the four quadrants of x-y coordinate system. If in each quadrant, the number of points in the scatter diagram is approximately the same, no linear relationship is indicated, and the sum of the products SXY will be numerically small.



To find the sample correlation coefficient, denoted by r, w e ^{2}, Sy^2 and SXY as was done for regression analysis. Then

$$r = \frac{\sum XY}{\sqrt{\sum X^2 \sum Y^2}}$$

The sample correlation coefficient r is a measure of the degree of the linear relationship between two variables.

Two Properties of r

(i) r is a number without units or dimensions, because it is a ratio of two quantities that are of the same product of X and Y. One useful consequence is that r can be computed from coded values of X and Y. No decoding is required.

(ii) r always lies between -1 and +1. Positive values of r indicate a tendency of X and Y to increase together. When r is negative, large values of X are associated with small values of Y.

Example

The computation of correlation coeffic:•nt can be demonstrated with the example on regression analysis given above.

$$r = \frac{\sum XY}{\sqrt{\sum X^2 \sum Y^2}} = \frac{1521.1}{\sqrt{140 \times 16910.49}} = 0.99$$

This implies very strong correlation. The significance of the correlation coefficient can be examined by postulating a Null Hypothesis that there is no correlation between X and Y. That is, the population coefficient is 0. The statistic to test is given by:

$$t = \frac{r}{\sqrt{\frac{1-r^2}{n-2}}} = \frac{0.99}{\sqrt{\frac{1-(0.99}{7-2}}}$$

For n = 7 or degree of freedom í = 5, the value of t from the student's t-distribution table at 5% level, $t_{0.05} = 2.015$. That is, the calculated t is greater than t from the table. We therefore reject the Null Hypothesis and accept the alternative. That is, the correlation coefficient of 0.99 is significant meaning that age of the plant (X) is linearly related to the height of the plant (Y).

COMPARISON OF TWO GROUPS: QUANTITATIVE DATA

Analysis of Differences

A research study may seek to analyse differences between means. For instance, if the objective is to ascertain the effect of some forms of instruction on pupils' performance, the difference between the variances of groups taught by differing methods can be tested easily. The t-test is relevant if only two groups are involved in the experiment while the Analysis of Variance (ANOVA) becomes relevant with more than 2 groups. Since the t-test and ANOVA are both inferential statistics, certain assumptions underline their use. One of these assumptions is that the observations (scores) are independent and the value of any one observation should not be related to the value of another observation. Another assumption is that the scores in the population are normally distributed.

Also, the Analysis of Covariance (ANCOVA) invented by Ronald Fischer is appropriate when the subjects in two or more groups are found to differ significantly on a pre-test or other initial variable. In this case, the effects of the pre-test and/or other relevant variables are adjusted and the resulting adjusted means of the post-test scores are computed.

The Student T-test

The student t-test has an underlying normal distribution and, as earlier mentioned, it is effective in situations where the sample size is less than 50 and the population standard deviation is estimated from the sample data. The major difference between the normal distribution and the student t-distribution is that the latter has more areas at the tails of the curve which is dependent on the degrees of freedom. Therefore a new Table of areas was constructed for the student t-distribution and simply called the t-table. The standard t-table is based on *n-2* degrees of freedom and when the sample size is more than 50 the t-table and Z-table have the same areas under different segments of the curve. In many clinical researches, the sample size is usually small and the values of the population standard deviation unknown. This explains why the student t-test is one of the most popular statistical tests with medical doctors when comparing two mean values.

$$s^2 = \frac{\sum(x_1 - \overline{n})^2 + \sum(x_2 - \overline{x}_2)}{n_1 + n_2 - 2}$$

or $$s^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)}{n_1 + n_2 - 2}$$

We start the t- test by setting a Null hypothesis that there is no difference in the means of the two samples being compared. That is, they are from the same population, which will imply that $\mu_1 = \mu_2$. The test statistic, simply written as t-test is as follows:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}}$$

The number of degrees of freedom is given by $(n_1+n_2)-2$ while $\bar{x}_1$ is the mean of the measurement in the first sample with size n_1, $\bar{x}_2$ the mean of the measurement in the second sample with size n_2 and s_1 and s_2 are the standard errors of the samples. When the t-value is evaluated, the probability of obtaining a value as extreme as that obtained under the null hypothesis is derived from the t-table at the appropriate degree of freedom.

Pooled Variance

Suppose we have two samples x_1 and x_2 of sizes n_1 and n_2 which have been drawn from two populations whose variance s^2 is unknown. The pooled variance of the two samples can be calculated.

Example

The mean time taken in days to regain birth weight by 20 children fed on the standard premium formula is 13.1 days with a standard deviation of 5.3 days. Another comparable group of 20 children fed on prematalac milk had a mean of 9.9 days and a standard deviation of 3.7 days to regain their birth weight. Is there a significance difference in the number of days to regain birth weight as a result of the different types of milk? Comment on your findings.

Solution:

Step 1: Set up a Null Hypothesis which states that there is no difference in the number of days taken to regain birth weight between the children fed on the standard premium and prematalac milk. That is, the two samples are from the same population.

$$H_o : \mu_1 - \mu_2 = 0$$

Step 2: Set up an Alternative Hypothesis that there is a difference between the means and hence the samples belong to two different populations.

$H_A : \mu_1 - \mu_2$ ¹ 0 or
H_A : Either $\mu_1 > \mu_2$ or $\mu_1 < \mu_2$

That is, no direction of the difference has been given and so we call this scenario a two-tailed test. But the second expression for H_A when a direction is given, we call a one-tailed test.

Step 3: The level error (·) for statistical significance is 0.05.

Step 4: The test statistics chosen is the student t-test for independent samples which according to the definition when Null Hypothesis is assumed is:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s^2_1}{n_1} + \frac{s^2_2}{n_2}}} = \frac{13.1 - 9.9}{\sqrt{\frac{5.3^2}{20} + \frac{3.7^2}{20}}} = 2.214$$

Step 5: Check the t-table for t_T at á = 0.05 and í =20+20 -2 =38 degrees of freedom. The value of t_T from table is 1.64.

Step 6: We now conclude that our data is not consistent with the null hypothesis and it appears that the difference in the average time to recover birth weight is statistically significant. In other words, it appears children on the new milk prematalac recovered birth weight more quickly. If we had used the pooled estimate variance (S^2) in calculating the standard error, the conclusions could have been the same. Thus pooled estimate of variance:

$$s^2 = \frac{19 \times 5.3^2 + 19 \times 3.7^2}{20 + 20 - 2} = 20.89$$

In that case, our calculated $t = \frac{131 - 9.9}{\sqrt{20.89\left(\frac{1}{20} + \frac{1}{20}\right)}} = 2.214$

with 38 d.f as before.

COMPARISON BETWEEN TWO MEAN VALUES: DEPENDENT GROUPS

As mentioned earlier, the design of the study may be such that it has some pairing properties where for each value of a variable in one group there is a twin relation in the other group. Such designs results when:

i. matching has taken place on all possible confounding factors that could cause systematic differences or

ii. observations are taken from the same experimental units at two different times say before and after an intervention (treatment). Units serve as self-control.

The student t-test used in this situation is called the Paired t-test.

Student paired t-test

The focus of analysis is on the difference between the individual pairs of observations rather than the difference between the means of each group. Therefore the mean of the differences between individual pairs is tested rather than the differences between the means. Thus paired t-test is given by the formula:

$$t = \frac{\bar{d} - 0}{\sigma}$$

where $\bar{d}$ is the mean of the differences between individual pairs and ó is the standard error of the differences between each paired observations. Recall the formula for the standard error of a mean as standard deviation divided by the square root of the sample size which is the number of paired observations in this case.

Paired Sample

Ten patients participated in a clinical trial of a new drug to control hypertension. Their systolic blood pressures before and after the use of the drug are as follows:

Patients	1	2	3	4	5	6	7	8	9	10
Before	160	140	180	160	225	150	150	140	170	165
After	140	150	170	130	180	120	150	120	130	140
d_i	20	-10	10	30	45	30	0	20	40	25

Is there any significant effect of the drug?

Solution: You should follow the six steps as in the previous example.

Step 1: Ho: $\bar{d} = 0$

Step 2: H_A: $\bar{d} \neq 0$

Step 3: á = 0.05

Step 4: choose student paired-t test.

t = ($\bar{d}$ - 0) / ó where $\bar{d}$ = Ód$_i$ / n = 210 / 10 = 21.0

and ó = $\frac{std.dev}{\sqrt{n}} = \frac{17.13}{\sqrt{10}} = 5.416$

That is, $t = \frac{21.0}{5.416} = 3.877$ on d.f. = n – 1 = 9

Step 5: Checking the table for the significance or P-value, we find P<0.05.

Step 6: Conclusion: The drug effect is statistically significant and it appears it has a lowering effect on systolic blood pressure.

QUALITATIVE DATA

Parametric test of significance

These are statistical tests whose models do not require strict conditions or assumptions about the form of distribution for the population parameters under test. Hence they are sometimes called *distribution-free methods*. It is specifically useful to test hypothesis on such data with any of the following characteristics:

i. Few observations

ii. Skewed distributions that cannot be transformed to normal distribution

iii. Graded responses usually on the nominal and ordinal scales of measurements

iv. Quick and easy analysis
v. Results requiring exact probabilities

Test of Means
To compare the average values computed from two independent samples, the non-parametric test to use is Mann-Whitney U Rank-Sum Test or the equivalent, Wilcoxon two sample rank tests. For paired samples, the Sign Test or the Wilcoxon signed Rank tests are used. The Analytic Approach is to use the relative positions of observations rather than their actual values in the ranking. Where the data of interest meet the assumptions underlying the parametric tests, the non-parametric tests are weaker! These tests will not be described here but can be found in statistical textbooks.

Further Qualitative Data Analysis
Standard statistical techniques exist for the analysis of qualitative data from focus group discussions and in-depth interviews. Recall that such data are usually collected as:

1. Text
2. Audio-taped Conversation/Responses
3. Observed Behaviour
4. Video-taped Behaviour

The method of analysis include

- Text coding;
- Intuition;
- Graphical displays;
- Grounded theory methods;
- Deconstruction;
- Levi-Straussian analysis and;
- Dream analysis.

MULTIVARIATE ANALYSIS
The multiple correlation coefficient (R), Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and other multivariate analysis techniques such as multiple regression, canonical correlation, discriminant analysis, factor analysis, path

analysis or causal modelling may also be used depending on the research question or hypothesis and data available.

MULTIPLE REGRESSION ANALYSIS

There are data situations when many variables are required to explain the dependent or response variables. In this regards, the regression of Y on a single independent variable is often inadequate. Two or more Xs may be available to give additional information about Y by means of a multiple regression on the X's. Some of the uses of multiple regression analysis are:

i. To construct an equation in the X's that gives the best prediction of the values of Y.
ii. To find the subset that gives the best linear prediction equation when there are many Y's.
iii. To discover which variables are related to Y, and, if possible to rate the variable in order of their importance.

Multiple regression analysis is a complex subject. The calculations become lengthy and cumbersome when there are numerous X-variables, and it is hard to avoid mistakes in computation. However, standard electronic computer programmes are available for such analysis.

Example

Multiple linear regression analysis may be illustrated by an investigation of the source from which maize plants in various soils obtain their phosphorus. Or the effect of certain socio-demographic variables on the values of systolic blood pressures. Results of an experiment to measure the concentrations of inorganic (X_1) and organic (X_2) phosphorus in different types of soil and the phosphorus contents (Y) of corn grown in such soils are shown in the table below these three variables. Let us consider how to determine X_1 and X_2 then determine Y

Soil Sample	X_1 (ppm)	X_2 (ppm)	Y
1	0.4	53	64
2	0.4	23	60
3	3.1	19	71
4	0.6	34	61
5	4.7	24	54
6	1.7	65	77
7	9.4	44	81
8	10.1	31	93
9	11.6	29	93
10	12.6	58	51
11	10.9	37	76
12	23.1	46	96
13	23.1	50	77
14	21.6	44	93
15	23.1	56	95
16	1.9	36	54
17	26.8	58	168
18	29.9	51	99

Solution

In this example, there were 18 soil samples; the multiple regression equation is as given in equation (1)

Prediction equation $Y = a + b_1X_1 + b_2X_2$ (1)

where $a = Y - b_1X_1 - b_2X_2$ (2)

$$b_1 = \frac{(\sum x_2^2)(\sum x_1y) - (\sum x_1x_2)(\sum x_2y)}{(\sum x_1^2)(\sum x_2^2) - (\sum x_1x_2)} \quad (3)$$

$$b_2 = \frac{(\sum x_1^2)(\sum x_2y) - (\sum x_1^2)(\sum x_1y)}{(\sum x_1^2)(\sum x_2^2) - (\sum x_1x_2)} \quad (4)$$

x_1 is obtained by subtracting X_1 bar$_1$ from each X_1

$x_1 = X_1 - \bar{X}$, $x_2 = X_2 - \bar{X}_2$ and

$y = Y - \bar{Y}$

$\bar{X}_1$, $\bar{X}_2$ and $\bar{Y}$ are the means of X_1, X_2 and Y, respectively.

It is advised to construct another table as follows to facilitate the calculation of these quantities.

Substituting the values, we have

$$b_1 = \frac{(315578 \times 3231.48) - (1085.61 - 3231.48)}{(1752.96 \times 3155.78) - (1085.6)^2} = 1.7898$$

Similarly, $b_2 = 0.0866$ such that;

$a = Y - b_1X_1 - b_2X = 81.28 - (1.789 \times 8911.94) - (0.0866 \times 42.11) = 56.26$

and the prediction equation $Y = a + b_1X_1 + b_2X_2$

That is, $Y = 56.26 + 1.7898X_1 + 0.0866X_2$

Soil Samples	X_1	X_2	Y	$y(Y-\bar{Y})$	$x_1(X_1-\bar{X}_1)$	$x_1(X_1-\bar{X}_1)$	x_1x_2
1	0.4	53	64	-17.28	-11.54	10.89	-125.67
2	0.4	23	60	-21.28	-11.54	-19.11	220.53
3	3.1	19	71	-10.28	-8.84	-23.11	204.29
4	0.6	34	61	-20.28	-11.34	-8.11	91.97
5	4.7	24	54	-27.28	-7.24	-18.11	131.12
6	1.7	65	77	-4.28	-10.24	22.89	-234.39
7	9.4	44	81	-0.28	-2.54	1.89	-4.80
8	10.1	31	93	11.72	-1.84	-11.11	20.44
9	11.6	29	93	11.72	-0.34	-13.11	4.46
10	12.6	58	51	-30.28	0.66	15.89	10.49
11	10.9	37	76	-5.28	-1.04	-5.11	5.31
12	23.1	46	96	14.72	11.16	3.89	43.41
13	23.1	50	77	-4.28	11.16	7.89	88.05
14	21.6	44	93	11.72	9.66	1.89	18.26
15	23.1	56	95	13.72	11.16	13.89	155.01
16	1.9	36	54	-27.28	-10.04	-6.11	61.34
17	26.8	58	168	86.72	14.86	15.89	236.13
18	29.9	51	99	17.72	17.96	8.89	159.66
Sum	215.0	758	1465	-0.04	0.08	0.02	1085.61
4321.02	4321.02	4321.02	4321.02	4321.02	4321.02	4321.02	4321.02
Mean	11.94	42.11	81.28				
Σ(sqrs)	4321.02	35076	131299	12389.61	1752.96	3155.78	

Soil Samples X_1 X_2	X_1Y	X_2Y	x_1y	X_2y	
1	0.16	25.6	25.6	199.411	-188.179
2	9.20	24.0	1380	245.571	406.661
3	58.9	220.1	1349	90.875	237.571
4	20.4	36.6	2074	229.975	164.471
5	112.8	253.8	1296	197.507	494.041
6	110.5	130.9	5005	43.827	-97.969
7	413.6	761.4	3564	0.711	-0.529
8	313.1	939.3	2883	-21.565	-130.209
9	336.4	1078.8	2697	-3.985	-153.649
10	730.8	642.6	2958	-19.985	-481.149
11	403.3	828.4	2812	5.491	26.981
12	1062.6	2217.6	4416	164.275	57.261
13	1155	1778.7	3850	-47.765	-33.769
14	950.4	2008.8	4092	113.215	22.151
15	1293.6	2194.5	5320	153.115	190.571
16	68.4	102.6	1944	273.891	166.681
17	1554.4	4502.4	9744	1288.659	1377.981
18	1524.9	2960.1	5049	318.251	157.531
Sum	10139.50	20706.20	63825	3231.48	2216.44

BLOCK	I_1					I_2					I_3					
	P_1	P_2	P_3	P_4	P_5	P_1	P_2	P_3	P_4	P_4	P_1	P_2	P_3	P_4	P_4	**Total**
I	0.9	1.2	1.3	1.8	1.1	0..9	1.1	1.3	1.6	1.9	0.9	1.4	1.3	1.4	1.2	**19.3**
II	0.9	1.3	1.5	1.9	1.4	0.8	0.9	1.5	1.3	1.6	1.0	1.2	1.4	1.5	1.1	**19.3**
III	1.0	1.2	1.4	2.1	1.2	0.8	0.9	1.1	1.1	1.5	0.7	1.0	1.4	1.4	1.3	**18.1**
Total	**2.8**	**3.7**	**4.2**	**5.8**	**3.7**	**2.7**	**2.9**	**3.9**	**4.0**	**5.0**	**2.6**	**3.6**	**4.1**	**4.3**	**3.6**	**56.7**

Data For Analysis

Grand Total, G = 56.7 N = ·45

Correction factor, $CF = \frac{(56.7)^2}{45} = 71.442$

Uncorrected sum of squares $\sum x^2 = 75.7$

TCSSQ (total) = 75.73 - CF = 4.288

$$\text{BSSQ (BLOCK)} = \frac{\text{Sum of square block total}}{\text{No. of yields per block}} - \text{CF}$$

$$= \frac{(19.3^2 + 19.3^2 + 18.1^2)}{15} - \text{CF} = 71.506 - 71.442 = 0.064$$

$$\text{TSSQ (treatments)} = \frac{\text{Sum of squares of treatment totals}}{\text{No. of yields per treatment}} - \text{CF}$$

$$= \frac{(2.8^2 + 3.7^2 \ldots\ldots\ldots\ldots\ldots\ldots 4.3^2 + 3.6^2)}{3} - \text{CF}$$

$$= 75.117 - 71.442 = 3.675$$

Predicted values

Soil Sample	X_1 (ppm)	X_2 (ppm)	Y	Y_p (ppm)	$Y-Y_p$
1	0.4	53	64	61.6*	2.4*
2	0.4	23	60	59.0	1.0
3	3.1	19	71	63.4	7.6
4	0.6	34	61	60.3	0.7
5	4.7	24	54	66.7	-12.7
6	1.7	65	77	64.9	12.1
7	9.4	44	81	76.9	4.1
8	10.1	31	93	77.0	16.0
9	11.6	29	93	79.6	13.4
10	12.6	58	51	83.8	-32.8
11	10.9	37	76	79.0	-3.0
12	23.1	46	96	101.6	-5.6
13	23.1	50	77	101.9	-24.9
14	21.6	44	93	98.7	-5.7
15	23.1	56	95	102.4	-7.4
16	1.9	36	54	62.8	-8.8
17	26.8	58	168	109.2	58.8
18	29.9	51	99	114.2	-15.2
Sum				1463.0	

*The predicted value Y_p can be estimated for each soil sample from the fitted regression. For soil 1 for example, $Y_p = 56.26 + 1.7898\,(0.4) + 0.0866(53) = 61.6$ppm. The predicted value for each soil sample has been calculated this way and tabulated in the table above. The quantity $Y - Y_p$ is the deviation, which measures the failure of the X's to predict Y.

+ *1.789 8 (0.4) + 0.0866(53) = 61.6pp*m. The predicted value for each soil sample has been calculated this way and tabulated in the table above. The quantity $Y - Y_p$ is the deviation, which measures the failure of the X's to predict Y.

For soil 1, $Y - Y_p = 64 - 61.6 = +2.4$ ppm. The other values have been calculated and tabulated also in the table.

FURTHER ANALYSIS

In some disciplines such as plant breeding genetics and ecology, further analysis beyond the analysis of variance is often necessary and several statistical techniques are available for such further analysis. Some of these techniques include:

(i) Principal component analysis
(ii) Cluster analysis
(iii) Generation mean analysis

FURTHER ANALYSIS OF VARIANCE TECHNIQUES

In agricultural research studies, the main focus is to increase productivity. Productivity may be in terms of yield. That is, increase in quantity, quality, and other desirable attributes such as size and shape. In order to achieve the set objectives, it is imperative to carry out the needed experiments either in glass-houses or in the field with well-considered experimental designs. The general rule is that the simplest design is likely to provide the required precision. A good experimental design is necessary for the collection of data so that differences among individuals or differences associated with the way the data were collected can be removed from experimental error. Some of the designs commonly used in agricultural research are the following:

(i) The Complete Randomized Design
(ii) The Randomized Complete Block Design
(iii) Latin Square Design
(iv) The Split Plot Design
(v) The Split-Split Plot Design

The statistical analysis must reflect the effort in these designs to reduce sampling variation. In this section, only examples of the use of Randomized Complete Block design will be given because it is the most commonly used in field trials.

RANDOMIZED COMPLETE BLOCK DESIGN

This design will be employed to find out the effect of different levels of nitrogen fertilizer on the grain yield of a maize cultivar (FARZ 27).

The nitrogen levels:

N_o - No nitrogen applied
N_1 - 25 KgN/ha
N_2 - 50 KgN/ha
N_3 - 100 KgN/ha

Number of replicates: 5

The grain yield (t/ha) at the harvest can be arranged into Blocks and Treatments as follows for ease of analysis.

	Nitrogen Levels				
Block	N_o	N_1	N_2	N_3	TOTAL
1	5.5	6.4	6.6	7.1	25.6
2	5.7	6.0	6.3	6.8	24.8
3	4.6	5.1	5.6	6.7	22.0
4	3.2	3.6	4.7	5.3	16.8
5	2.7	3.4	4.0	3.9	14.0
Total	21.7	24.5	27.2	29.8	103.2
Mean	4.34	4.90	5.44	5.96	

Grand Total, G = 103.2 Total number of values (N) 5 X 4 = 20

Analysis:
Step 1: Calculate Correction Factor (CF)

$$CF = \frac{G^2}{N} = \frac{(103.2)^2}{20} = 532.512$$

Step 2: Calculate the Total corrected sum of squares (TCSSQ)

Total SOS = (Total uncorrected sum of squares) - CF

$$= 5.5^2 + 6.4^2 .... 4.0^2 + 3.9^2 - CF = 566.46 - 532.512 = 33.948$$

Step 3: Calculate Block BSSQ

$$\text{Block BSSQ} = \frac{\text{Sum of squares of block total}}{\text{Number of replications per block}} - CF$$

$$= \frac{25.6^2 + 24.8^2 + 22.0^2 + 16.8^2 + 14.0^2}{4} - CF$$

$$= 558.16 - 532.512$$

$$= 25.648$$

Step 4: Calculate Treatment TSSQ

$$\text{Treatment TSSQ} = \frac{\text{Sum of Squares of treatments Total}}{\text{Number of replications per treatment}} - CF$$

$$= \frac{(21.7^2 + 24.5^2 + 27.2^2 + 29.82)}{5} - 532.512$$

$$= 7.292$$

Step 5: Calculate Residual Sum of Squares (RSSQ)

RSSQ = SOS total – SOS blocks – SOS treatments
= 33.948 – 25.648 – 7.292
= 1.008

Step 6: Calculate the degrees of freedom (d-f)

Blocks d.f. $= r - 1 = 5 - 1 = 4$
Treatment d.f. $= t - 1 = 4 - 1 = 3$
Residual d.f. = Total d.f. – Block d.f. – Treatment (d.f)
$= 19 - 4 - 3 = 12$

Step 7: Complete Analysis Of Variance Table

Source	Deg of freedom	SOS	MS VR
Block	4	25.648	6.4120 76.33
Treatments	3	7.292	2.4307 28.94
Residual	12	1.008	0.0840
Total	19	3.9483	

NOTE:

(i) Mean square (MS) is calculated by dividing the sum of squares by degree of freedom.

(ii) The variance ratio (VR) is obtained by dividing the treatment mean square (2.4307) by the residual mean square (EMS, 0.0840)

The VR for a block is calculated by dividing the Blocks Mean Square (BMS = 6.4120) by RMS.

Step 8: Conduct F – test

The Variance Ratio (VR) for treatments is 28.94 on (3,12) d.f. To test at 5% level the hypothesis of no difference in treatment effects, we look up ($F_{3, 12; 5\%}$) in the 5% F-table. The entry in column 3 and row 12 is 3.49 i.e. $F_{(3, 12, 5\%)} = 3.49$. Our value of 28.94 is much greater so we conclude that there is evidence that the treatments have different effects.

For 1% the $F_{(3, 12, 1\%)} = 5.95$ is still greater, so there is strong evidence of a difference in the treatment effects. For 0.1% the value is 10.80. The result is still greater, so there is a very strong evidence of different treatment effects.

In some cases, it may be necessary to quote a probability P-value. In this example, $P<0.001$. This means there is less than 0.1% chance of getting a Variance Ratio as great as the value of 28.94 if there were no underlying treatment differences.

Step 9: Compare treatment means.
Many researchers do not carry out this step if VR for the treatment is not significant. However, if the main aim of the experiment is to compare a particular treatment, say a control treatment with each of others, it is still valid to carry out a Least Significant Difference (LSD) even if VR is not significant.

Step 10: Calculate the Standard Error of the Difference (SED) between two treatments' means. This can be obtained using the RMS value from the analysis of variance table.

$$SED = \frac{\sqrt{2 \times RMS}}{r} = \frac{\sqrt{2 \times 0.084}}{5} = 0.1833$$

Step 11: Find the Least Significant Difference (LSD), start with 5% level.

LSD + 5% = $t_{(R.d.f., 2.5\%)} \times$ SED
R.d.f. = residual degree of freedom (12)
$t_{(12, 2.5\%)} \times$ SED = 2.179 X 0.1833 = 0.399 t/ha

Step 12: Compare differences between means with LSD value. In this example, treatment 1 (N_o) is the control treatment so we may wish to compare treatments 2, 3 and 4 with treatment 1.

$N_1 - N_o$ = 4.90 – 4.34 = 0.56
$N_2 - N_o$ = 5.44 – 4.34 = 1.10
$N_3 - N_o$ = 5.96 – 4.34 = 1.62

All these differences are greater than the LSD value of 0.399 so we conclude that the three nitrogen levels are significantly different from the control.

We can go on and find LSD at 1%. At this level, only N_2 and N_3 are significantly different from N_o and at 0.1%, N_2 and N_4 are still significant. The conclusion one can draw here is that the grain yield of maize at 50 KgN/ha is not significantly different from the grain yield of maize grown with 100 KgN/ha.

DUNCAN MULTIPLE RANGE TEST

Treatment means can also be compared using Duncan multiple range test. The test is the most widely used of several multiple range tests available. It gives protection against making mistakes inherent in the indiscriminate use of the LSD test. The test is identical to LSD for adjacent means in an array, but requires progressively lower values for significance between means that are widely separated in the array. This test is used most appropriately when several unrelated treatments are included in an experiment. For example, it is very useful for making all possible comparisons among the yielding abilities of several varieties.

The test involves the calculation of shortest significant differences (SSD) for all possible relative positions between the treatment means when they are arrayed in order of magnitude. The SSDs are then used in an orderly procedure to determine the statistical difference among the means. The formula SSD is R (LSD) where R is a value from a table of significant studentized factor and is chosen according to the level of significant desired degree of freedom for error and the relative separation of means in the array. For further details see *Statistical Methods in Agricultural Research* by T.M. Little and F.J. Hills.

FACTORIAL EXPERIMENTS

INTRODUCTION

In most agricultural research studies, there are always several factors (environmental and treatment) involved. For example, if an Agronomist wishes to assess the economic potential of a new variety of a crop, such as cowpea, he would be required to produce data on the response of the crop to fertilizers, density, insecticides and weeding requirements. To test the variety for each individual requirement would be tedious, time consuming and expensive. In addition it gives no measure of possible interactions between different factors and in statistical terms may give a poor estimate of standard error.

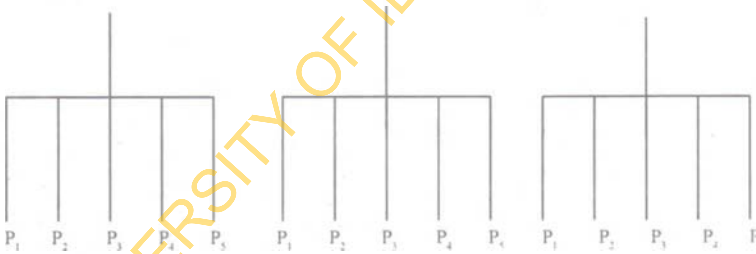
All these problems can be overcome by using a Factorial Experiment. Factorial experiments are appropriate when there are two or more types of treatments to be applied in different amounts, which can be applied together or alone. In statistical terms, this sort of treatment is called a *Factor;* and the amount applied is the ***Level*** of the factor. The essence of the factorial experiment is that the treatments are made up of all possible combinations of the different factors. For instance in a two-factor experiment there may be

A = NITROGEN FERTILIZER
B = INSECTICIDES

In a three-factor experiment, the additional factor may be

C = SEEDING RATE

Example with interpretation
A factorial experiment was carried out in order to determine the response of cowpea cultivar (Vita 4) to 3 levels of a new insecticide for the control of Maruca (I_1 I_2 I_3) and 5 levels of phosphate fertilizer (P_1 P_2 P_3 P_4 P_5). The experiment was replicated 3 times. This is a 3 ×5 factorial experiment having the following (3 × 5 ×3) 15 combinations.



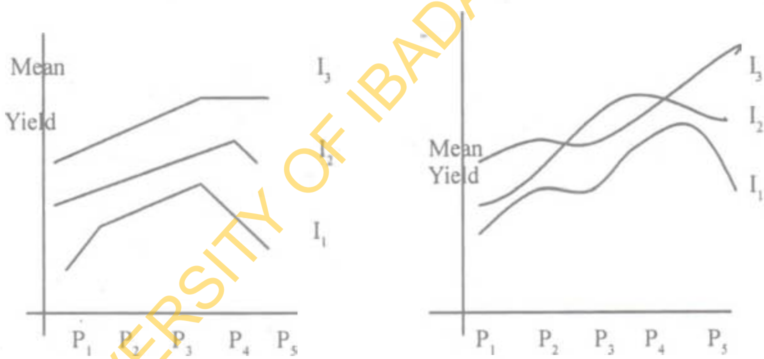
The treatment combinations are:

I_1P_1	I_2P_1	I_3P_1
I_1P_2	I_2P_2	I_3P_2
I_1P_3	I_2P_3	I_3P_3
I_1P_4	I_2P_4	I_3P_4
I_1P_5	I_2P_5	I_3P_5

A randomized design with 3 replications was adopted. The 15 treatments were randomly assigned to the plots within each block. A separate randomization was carried out for each block.

This experiment can be used to explore the following objectives.

1. The main effect of phosphorus fertilizer on the yield of cowpea when averaged over levels of insecticides.
2. The main effect of insecticide on the yield of cowpea when averaged over levels of phosphorus.
3. ***Interaction:*** If the response curves to nitrogen fertilizer are not the same for the three levels of insecticides, this is equivalent to saying that the differences between insecticide yields are not the same at each phosphorus level. If the increase in yield in going from one phosphate fertilizer level to the next is not the same for all insecticides this indicates interaction (see Fig.)



In the first diagram there is no interaction as the response curves are parallel. I_3 gives higher yields than I_2 and I_1 by fixed amounts at each level of P. The second illustrates interaction. I_3 gives higher yields than I_2 and I_1 at phosphorus levels P_1, and P_2 and P_5 but gives lower yields than I_2 at phosphorus levels P_3 and P_4.

If there is a significant interaction it does not make sense to compare the main effects of nitrogen or insecticides. We should compare the effects of insecticide at each level of phosphate or the effects of phosphate at each level of insecticide.

The Residual Sum of Squares (RSSQ) is found as follows:

RSSQ = TCSSQ (total) – BSSQ (BLOCK) – TSSQ (treatments)

$$= 4.288 - 0.064 - 3.675 = 0.549$$

The treatment TSSQ (SOS (treat) which has 14 d.f can be split into three parts, i.e.

TSSQ (treat) = TSSQ (phosphate) + TSSQ (Insecticide) + TSSQ (Interaction)

To facilitate the calculation of these SOSs see the following table:

	P_1	P_2	P_3	P_4	P_5	**Total**
I_1	2.8	3.7	4.2	5.8	3.7	**20.2**
I_2	2.5	2.9	3.9	4.0	5.0	**18.3**
I_3	2.6	3.6	4.1	4.3	3.6	**18.2**
Total	**7.9**	**10.2**	**12.2**	**14.1**	**12.3**	**56.7**

From this table the following calculations are made:

$$\text{SOS (phosphate)} = \frac{\text{Sum of Squares of Phosphorus}}{\text{No. of yield per phosphate level}} - \text{CF}$$

$$\frac{(7.9^2 + \ldots\ldots\ldots\ldots\ldots\ldots + 12.3^2)}{9} - \text{CF}$$

$$= 73.932 - 71.442 = 2.490$$

(We divide by 9 because there are 9 original yields for each nitrogen level).

TSSQ (Insecticide)

$$= \frac{\text{Sum of Squares of Insecticides Total}}{\text{No. of yields per insecticide level}} - \text{CF}$$

$$\frac{(20.2^2 + 18.3^2 + 18.2^2)}{15} - \text{CF}$$

$$= 71.611 - \text{CF} = 0.109$$

TSSQ (Interaction) = TSSQ (treatment) – TSSQ (phosphate) – TSSQ (Insecticide)

$$= 3.675 - 2.490 - 0.169 = 1.016$$

Below is the ANOVA table :

Source	d.f	SSQ	MS	VR	dfused
Blocks	2	0.064	0.0320	1.63	
Phosphate (P)	4	2.490	0.6225	31.76	on (4,28 d.f)
Insecticide (I)	2	0.169	0.0845	4.31	(2,28 d.fN X
P x I	8	1.016	0.1270	6.48	(8,28 d.f)
Residual	28	0.549	0.0196		
P x I (interaction)	44	4.288			

Interpretation

From statistical tables ($F_{8,28}$, 1%) = 3.23, so the interaction value of 6.48 is highly significant. In order to interpret the treatment effects we should make comparison using a two-way table of phosphate and insecticide means (see table below).

The appropriate standard error is

$$SED_{(\text{interaction})} = \frac{\sqrt{2 \times RMS}}{r} = \frac{\sqrt{2 \times 0.0196}}{3} = 0.1143$$

where r = number of replications

RMS = Residual Mean Square

If the interaction had not been significant we could compare overall Nitrogen means using:

$$SED_{(P)} = \frac{\sqrt{2 \times RMS}}{r \times g} = \frac{\sqrt{2 \times 0.0196}}{9} = 0.066$$

where r = replications (3) and g = no. of levels of insecticide (3)

Also, the overall insecticide means can be compared:

$$SED_{(I)} = \frac{\sqrt{2 \times RMS}}{r \times n} = \frac{\sqrt{2 \times 0.0196}}{15} = 0.0511$$

where r = replications (3) and n = no. of levels of phosphate fertilizer (5)

Table of Phosphate Fertilizer x Insecticide Means

	P_1	P_2	P_3	P_4	P_5	Mean
I_1	0.93	1.23	1.40	1.93	1.23	1.35
I_2	0.83	0.97	1.30	1.33	1.67	1.22
I_3	0.87	1.20	1.37	1.43	1.20	1.21
Mean	0.88	1.13	1.36	1.57	1.37	

OTHER SPECIAL STATISTICAL ANALYSES

Economic Analysis: Economic Evaluation of Plantation Establishment in Forestry

Introduction

Any productive economic activity produces benefits in the form of goods and services and involves costs in the form of materials consumed and the time of productive factors diverted from other useful employment. According to Worell (1970), a comparison of these benefits and costs gives information for policy decisions. A consideration of benefits and costs leads to a rather obvious basic economic criterion. An activity should not be undertaken unless its total benefits exceed its total costs. An example of economic evaluation of land use deals with production between two alternatives as indicated below.

Economic Evaluation of Land Use

Given the two hypothetical tables below, at a discount rate of 10%, two methods of plantation establishment (Taungya and Direct plantation) were employed on an 8-year rotation to determine economic efficiency of land use. Each method was allotted one hectare of land. As a forest economist, which of these two methods of plantation establishment will be prescribed for economically efficient use of land? State attributes of economic efficiency of your choice.

Objective
To prescribe the plantation establishment method that is economically efficient for land use.

Data Preparation
Table 1: Cash Flow Analysis: *Tectona grandis* Direct Plantation (N/ha) on eight year rotation in Osun State.

Year	Costs	Benefits N	Discount Rate10%	Present Value Cost (PVC)	Present Value Benefit (PVB)	Present Value Benefits minus Present Value Cost (PVB-PVC)
1	650.24	-	0.909	591.07	-	-591.07
2	103.16	-	0.826	85.21	-	-85.21
3	51.76	-	0.751	38.87	-	-38.87
4	19.66	-	0.683	13.43	-	-13.43
5	19.66	-	0.621	12.21	-	-12.21
6	19.66	-	0.564	11.09	-	-11.09
7	19.66	-	0.513	10.09	-	-10.09
8	-	3,850	0.467	-	1797.95	1797.95

Economic Analysis
In order to prescribe the plantation establishment that is economically efficient, the following criteria are used for calculation:

(A) *Net Present Value (NPV):* This measures the profit or surplus income from a project after the project has satisfied the rate of return on capital desired by investor. This rate of return desired by investor is used to discount both the costs and revenues of the project. Net Present Value (NPV) is estimated with the formula:

$$NPV = \sum_{t=1}^{n} \frac{(B_t - C_t)}{(1+i)^t}$$

where B_t = Benefits in each project year t
C_t = Costs in each project year t
n = Number of years to the end of project
i = Discount rate

Computation involves six steps

1. A discount rate of 10% obtained from the bank
2. Yearly cost and benefits identified till the rotation age of projects or period under investigation
3. Cost and benefits discounted and presented for every year
4. Costs and benefits estimated in monetary value per year
5. Discounted gross costs and benefits estimated for the rotation year
6. The net values added to obtain NPV

(A) *Benefit-Cost Ratio(B/C)*: The B/C Ratio expresses the sum of the discounted benefit as a ratio of the sum of the discounted cost. According to this criterion, one accepts a project for implementation if the B/C is equal to or greater than one.

Formula:

$$B/C = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+i)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+i)^t}} \geq 1$$

The same steps above are applicable for computation.

Formula for Discount Rate = $\frac{1}{(1+i)^t}$

Calculation

A. Table 1 (Teak Plantation –Direct)

(i) Present Value Cost (PVC) = N 761.97
(ii) Present Value Benefit (PVB) = N 1797.95
(iii) Net Present Value (NPV) = PVB – PVC =
= N (1797.95 -761.97)
= N **1035.98**
(iv) Benefit- Cost Ratio (B/C) = $\frac{N\ 1797.95}{N\ 761.97}$ = **2.36**

NPV = N 1035.98 while B/C = 2.36

B. Table 2 (Taungya Teak Plantation)

(i) Present Value Cost (PVC) = N 306.55
(ii) Present Value Benefit (PVB)= N 1814.99
(iii) Net Present Value (NPV) = PVB – PVC
=N (1814.99 – 306.55)
= N 1508.44
(iv) Benefit- Cost Ratio (B/C) = $\frac{N\ 1814.99}{N\ 306.55}$ = 5.92

NPV = N 1508.44 while B/C = 5.92

Interpretation and Inference

For economically efficient use of land employing 1 hectare for two methods of plantation establishment each, Tungya Teak plantation is prescribed because the NPV (N1508.44) and corresponding B/C (5.92) are greater than Direct Teak NPV (N1035.98) and B/C (2.36). Taungya is more economical, desirable, acceptable and profitable than Direct Teak plantation.

Attributes of Economic Efficiency

i. Discounted benefit of Taungya is greater than discounted benefit of Direct Teak plantation
ii. Discounted cost of Taungya is less than Discounted cost of Direct Teak plantation
iii. Net Present Value of Taungya is greater than Net Present Value of Direct Teak Plantation
iv. Taungya is used for conflict resolution between gov-

ernment and rural dwellers where there is land hunger

v. Taungya can compete in the short run with agriculture for land use.

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DATA RETRIEVAL AND USE OF ICT IN RESEARCH

O. A. Fakolujo

PREAMBLE

A wide range of developments in ICT, covering hardware, software and networking technologies, bring about ongoing changes in the science system and research methodology. They include significant improvements in computing power and storage capacity and better networking and search technologies. Such developments have allowed scientists and researchers to make rapidly increasing use of Internet and ICT tools. However, there are concerns that the Internet is becoming inadequate for certain scientific purposes. Several governments and universities have recently taken initiatives to develop faster networking technologies to meet the needs of science. ICT-related changes underlying the evolving science system have three main sources:

- Technological change in the ICT industry (mostly driven by needs unrelated to science)
- Scientists' and Researchers' efforts to develop their own tools; and
- Government programmes specifically designed to foster developments in ICT and apply them to scientific needs, e.g. the US High-Performance Computing and Communications (HPCC) programme.

The application areas of ICT include:

- Research activities
- Job search
    a. You can reach deeper into your local area as well as take your search far beyond your regular boundaries
    b. You can access current information at all hours of the day or night
    c. Using the Internet in your search demonstrates leading-edge skills
    d. The Internet lets you meet new people and initiate new relationships with others in your profession or region
    e. The Internet can help you explore career alternatives and options that you maybe haven't considered
- Fund Raising: securing grant
- For marketing

MAIN TECHNOLOGICAL DEVELOPMENTS

Conventional computers solve problems by performing programme instructions one at a time in a strict sequence. Electronics manufacturers have provided users with increasing computing power at decreasing cost for many years, essentially by squeezing a greater number of ever smaller transistors and other components onto chips, thanks to continuous advances in lithographic techniques (*Science,* 1996). They have also found alternative ways of getting more processing power from computers, for example by using reduced instruction set computer chips (RISC) or special-purpose chips to perform designated tasks faster than a general-purpose processor (*New Scientist,* 1996).

The supercomputers used for research generally have custom-made, expensive processors which provide better performance. Up to the late 1980s, vector supercomputers were the most powerful computers. They were the only option for researchers with truly large problems, who used them to perform calculations simultaneously on long strings of numbers, i.e. vectors (Pool, 1995). The research potential of parallel computers has been demonstrated more recently. These multiprocessor machines break major programming tasks down into smaller problems which they solve simultaneously. This method remains quite difficult, however, and cannot be used to solve all problems.

Cheaper off-the-shelf components and software have generally contributed to increased use of information technology. A new generation of extremely powerful off-the-shelf commodity chips is also at the heart of an emerging standard parallel architecture (Matthews, 1996). Even working on their own, these chips attain speeds of up to 200, 300 or 600 million flops (floating point operations per second). Many off-the-shelf components are also available for certain scientific instruments. Plug-in circuit cards allow new features to be added to personal computers (PCs) without much adjustment. Complex software, increasingly available for Windows Operating System (OS), contributes to the use of technology by non-specialists at lower cost. Various storage and information delivery technologies continue to co-exist.

Traditional storage systems such as the CD-ROM (compact disk – read only memory) are still being used by publishers, particularly where current Internet access limitations would result in very slow access, e.g. when the package contains great quantities of data. New products that combine CD-ROM data with information on the World Wide Web (WWW) or online services give publishers the opportunity to deliver huge amounts of data on CD-ROM and then use the Internet to offer updates or transactions. The Digital Video Disk (DVD) can store seven times as much data as a CD-ROM and deliver a moving picture quality that outshines laser disks. It is particularly useful for multimedia publishing and will enable educational software, in particular, to incorporate more video. The mass-storage industry continues to develop technologies that can handle increasing quantities of data, thereby satisfying the needs of scientists carrying out large-scale simulations, experiments and observation projects.

Electronic networks constitute the infrastructure which provides scientists with new means of communication that give them access to data, information and software in cyberspace, allow them to share and control remote instruments, and that link distant learners to virtual classrooms and campuses. Scientists currently have access to various types of networks, including campus, national and international research networks, which are increasingly interconnected. The main network, the Internet, began in the late 1960s as a network providing a limited number of researchers with shared interactive communication among computing systems at different locations. It has become a network of networks that can be accessed by anyone with a computer and a modem. Since 1991, the WWW has been a very powerful and convenient way to navigate through the world's collection of networked computers. Through hypertext links, it connects information on the network to other sites. Special graphical interfaces known as Web browsers, such as Netscape Navigator, Microsoft Internet Explorer and Netcom NetCruiser, allow users to read hypertext.

Rapid advances in computing power and the explosive growth in network connectivity have generally enhanced the use of distributed systems. The potential of networking several computers to perform tasks similar to those performed by supercomputers is also being tested. In addition, systems capable of co-ordinating different types of computers, including traditional supercomputers, parallel computers, workstations and PCs, are emerging (Economist, 1996). Hardware and software for using a network of workstations as a distributed computing system on a building-wide scale are being developed (National Science and Technology Council, 1995).

The development and use of digital data and information rely on a broad range of technologies. Non-digital data requires data acquisition technology, such as optical character recognition, while direct use of data collections requires database management systems. Text analysis and information retrieval techniques (including text, index and image compression, indexing, routing, filtering and visualization techniques) sometimes enhanced by artificial intelligence, are needed to index, search, retrieve and present information. Furthermore, data mining technologies can be used to filter large amounts of data for useful patterns. Methods for handling information help users more effectively search, learn about, organize and use data and information. Search tools, for example, can go through millions of articles from current and back issues of electronic journals in almost any discipline. They help users navigate online services and save time. Search engines such as Altavista, Excite, Infoseek, Lycos, Web 12 Crawler and Yahoo constantly tunnel through and catalogue Internet documents. There are also limited area search engines that index only Internet resources relevant to a specific subject and thus raise the speed and efficiency of searches. Internet search technology is still, however, in its infancy.

Many ICT applications used by scientists, such as access to databases, information services and e-mail, were originally based on narrowband technologies; broadband technologies were only needed for video applications. However, the growth of the Internet and new interactive – often multimedia – applications has led to a rapidly growing demand for high bandwidth technology, which may also be needed to process large amounts of data.

COMMUNICATION AMONG RESEARCHERS

Researchers have used ICT-based communications – or the Internet – mostly as a natural extension of other communications tools. Apart from greatly enhancing the quantity, quality and speed of communication among researchers, ICT use has also had various effects on the organization of research work. Collaboration patterns have changed, research work base has widened as more researchers are able to participate, and the hierarchies have sometimes been affected.

The Growth of Collaborative Arrangements

Improved communication due to ICT may contribute to an increase in the size of professional networks. For example, among oceanographers, intensive e-mail users report larger professional networks. In biology, chemistry, mathematics and physics, collaborations have also increased in size, apparently in association with the use of ICT. In experimental particle physics, the Internet has facilitated experiments in which a large number of people collaborate effectively. A more significant change in the organization of research has been the increase in remote collaboration, particularly at international level. Computer networks have reduced the need for co-workers to be at a single location. Consequently, a new form of research work has emerged, the "extended research group". This is typically a large, unified, cohesive, co-operative research group that is geographically dispersed, yet co-ordinated as if it were at one location and under the guidance of a single director. It provides access to colleagues and to equipment, software and databases that are traditionally part of laboratory organization, without regard to geography. These "collaboratories" rely heavily on ICT for coordinating their work.

E-mail over the Internet enables researchers to overcome many barriers to communication due to geographic distance, such as time, costs and language. The main requirement is that all members of the group have Internet addresses. E-mail was preferred to the telephone because scientists who travel may be hard to reach by phone, but can be contacted at their virtual address, because written messages allow time for formulating answers before responding, and because colleagues whose native language is not English preferred written communication. Therefore, E-mail is considered next best to face-to-face interaction and a good medium for facilitating collaboration among researchers. However, many researchers emphasize the importance of establishing common understanding of the research problem through intensive, face-to-face interaction before engaging in computer-mediated collaboration. For example, the modiago scholarship presently has two students from the Department of Electrical / Electronic Engineering, University of Ibadan (Nigeria) and two others from another country working on the same project yet not debarred by geographical distances.

With closer links among geographically dispersed researchers, the international community of scholars is becoming denser. For a given research topic, ICT allows the creation of more complex work groups with more fluid structures. Virtual research teams can be formed and link a variety of researchers, each of whom contributes his or her skills to the project. Projects take advantage of networks to obtain access to the precise skills needed, and researchers gain access to projects that demand their skills. As a result, the research topic, rather than geographical proximity, determines collaboration decisions.

Effects on Status and Hierarchy

ICT-based communication can lead to greater decentralization or less difference in status, because interaction over the Internet provides fewer clues to status, rank, and gender than face-to-face or even mail or phone communication (Walsh, 1997). Group decisions are consequently less influenced by the status of those proposing particular solutions. Moreover, by its informal nature, e-mail reduces lower-level researchers' caginess about contacting higher-level ones. It may facilitate the creation of new ties among remote collaborators and give researchers with lower status easier access to their more eminent colleagues with whom they may eventually publish results jointly. On the other hand, it may create even greater disparity in publication rates as top researchers become attached to a greater number of research projects via e-mail contacts. E-mail communication may also allow researchers who previously lacked the access necessary to keep up to date to become active participants and possibly core researchers. So far, no significant correlation has been found between age or institutional prestige and ICT use as a predictor of productivity (Cohen, 1995).

To the extent that status distinctions remain however, individuals with high status will continue to exert more influence on group decisions. As the technology has been developed, more status cues are being inserted into the communication. E-mail addresses, for example, are evolving from a nondescript assembly of letters and numbers to a combination of family name, institution or company, and country of registration. Also, other mechanisms for introducing the status-reinforcing procedures of earlier communication technologies (mail, telephone) are beginning to appear. For example, high-level researchers increasingly use gatekeepers to screen their e-mail just as they screen letters and calls. Similarly, if ICT violates existing work norms or status distinctions, it may not be used. New technology can also change part of the basis for existing status distinctions. ICT can, for example, enhance the status of younger colleagues who are more familiar with the latest technology. It may also provide peripheral researchers with wider access to crucial resources – such as computing facilities, software or databases – which have traditionally been unequally distributed. Improved access could reduce the gap between more and less eminent researchers.

In general, ICT has allowed more researchers to have access to the latest information and thus remain up to date. This has been particularly meaningful for those at less prestigious institutions. However, there is a significant difference between having access and being present. Researchers at top institutions have access to oral information and seminars as well as research papers. They also have access to specialists who know which information and papers are important. The filtering provided by local and informal communication is an important part of the process of finding research information. Researchers at large institutions usually also have better access to funding and equipment.

Generally, while ICT helps improve access to information, it does not overcome disadvantages due to a lack of direct contact with top scholars in the field. ICT use may thus lead more to a broadening of the resource base than to a change in the hierarchy of institutions. While ICT can be used to provide broad access to resources, it can also be used to limit access. Netnews bulletin boards are generally open to many users and are used to announce new findings, discuss substantive issues, and receive answers to questions from unknown colleagues. More field-specific distribution lists may be announced through direct contact with existing research ties, thus enabling a more specialized exchange of information. Some fields seem to have more potential to benefit from technology than others.

ACCESS TO INFORMATION

Rapid advances in ICT have made it possible to handle digital data and information in large volumes at ever-increasing speeds and have resulted in sharp reductions in the cost of storing, filtering, processing, compressing, and retrieving data for interpretation and retransmission. ICT has increased researchers' ability to access information by supplying them with increasingly powerful tools at decreasing cost, thus enabling new ways of working. Researchers have frequently been the first to use ICT in a new or comprehensive way, as in the case of the Internet. On the whole, this has significantly improved the efficiency of information -based work.

Digital Resources for Researchers

In the past, traditional libraries held the keys to research and knowledge. Today, "digital libraries" store and manipulate large collections of material in electronic form. The development of digital libraries is closely linked to that of network information systems, which increasingly allow access to resources when and where users desire it. Prodigious quantities of general and sector-specific information are now available off-line on CD-ROMs and online, increasingly over the Internet. With ICT, access to this information can already be obtained at low incremental cost. As systems become more sophisticated, users will benefit from a growing capacity to navigate among information resources at low cost.

Databases

The value of scientific and technical databases to research organizations continues to increase. Estimates suggest that both the amount of data they contain and their total number expand by about 10 percent a year. Internet tools, in particular, have made information more readily available to a growing base of scientists and engineers, as database service providers have started moving to Web-based systems. Web browsers such as Netscape are excellent database interfaces; their broad acceptance has extended the potential user base to the research community (R& D Magazine, 1997).

Several factors help make data sets collected by scientific projects available to broad communities of users. Since the tools used to collect, transmit, and analyse data generate or require digital signals, the data are already in digital form and are therefore easily communicated over digital networks in a timely way to researchers world-wide. Furthermore, when researchers have public support for major research projects, they are encouraged to disseminate data widely so as to maintain that support.

Digital Library Initiatives

There are vast numbers of projects for developing digital libraries. They currently focus on issues of access costs and digitization technology. The key technological issues, however, are how to search and display desired selections from large collections on the Internet. Research on digital libraries concentrates on how to develop the necessary infrastructure to manipulate effectively the massive amounts of internet information (Computer, 1996).

Many traditional libraries which are not yet involved in large-scale digitization of publications are nevertheless increasing their holdings of electronic documents. These can be powerful tools for research and may reduce subscriptions to printed publications by enabling electronic access to other libraries' holdings. A "free-rider" problem may arise, however, if all libraries follow this policy. Access to unpublished student research stored at universities is generally limited, thereby reducing the transfer of knowledge contained in unpublished scholarly work. It is estimated that over 10 percent of all research performed in the hard sciences each year had already been done. Providing electronic access to this data source might improve scientists' productivity by enabling them to focus on the appropriate issues.

The Digital Library Initiative (DLI) is the flagship research effort of the US National Information Infrastructure Initiative. Ultimately, the digital library would involve an entire network of distributed repositories where objects of any type can be searched within and across indexed collections. With its many partners and large testbeds, the DLI is structured to encourage technology transfer. Once the DLI has stimulated basic research in various enabling technologies and enabled several digital library testbeds, it is expected that IT companies, traditional libraries, publishers, organizations, and users will join forces to develop the knowledge repositories that will play an essential role for all of society in the 21st century.

EDUCATION AND TRAINING OF RESEARCHERS

ICT contributes directly to teaching, learning, and research and provides a support function to researchers by enabling access to digital libraries, archives, databases and information services. ICT can have positive effects on learning by opening up access to educational resources, by supporting the learning process, and by supporting skill development. However, this requires efficient planning, and learners, teachers, and institutions that are willing and able to adapt.

The enhanced use of ICT in teaching may also help to improve academic productivity, thus enabling researchers to spend more time on research. Researchers may also need better education and training to use ICT efficiently for research work. ICT opens up access to education by removing many of the temporal and spatial constraints to information and knowledge. Furthermore, the availability of learning materials based on ICT can greatly improve learning resources. Computers support the learning process by helping to create a student-centred rather than a teacher-centred environment, one which is more flexible and adaptable to individual needs. Working groups formed around the computer can also help prepare learners for a world in which many problems are addressed by teams. Nevertheless, this potential can only be realized with high-quality software and significant efforts by all those involved (OECD, 1997).

Efficient use of ICT allows students to develop the kinds of skills and competencies that many educational reform panels have viewed as essential (OECD, 1997). Basic skills such as arithmetic can be mastered with computer-aided drill and practice, while writing skills can be developed with word processing, which makes writing and revising easier. A deeper understanding of complex scientific concepts in mathematics and science - particularly where experiments are not feasible or are dangerous - can be gained through computer simulations. Last but not the least, the use of these technologies for learning may establish familiarity with technologies that are increasingly needed by individuals in a technology-driven society.

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USE OF COMPUTERS AND THE INTERNET FOR RESEARCH PURPOSES

O. A. Bamiro, A. E. Oluleye & M. A. Tiamiyu

INTRODUCTION

ICT is understood as a complex of artefacts, techniques and knowledge for solving human problems involving information and its communication. One key feature is the employment of electronic rather than mechanical means for storing, processing and communicating information. Sometimes it is simply termed as the use of technology to handle information and aid communication (Stevenson 1997).

A number of synonyms are used interchangeably with the term ICT. These include: Information Technology, and Computer Technology. Some would argue that IT fully encapsulates ICT; that is the word *Communication* in ICT is somewhat superfluous. Others argue that the *Information* without being communicated is worthless in impacting development. What is clear is the need to identify the driving force – the computer and computer software and the need to make more efficient decisions that impact development in a significant way.

Until very recently the main forms of communication such as phones, fax machines, electronic mail were used by a select band of people, who were considered as elites in society. Today, these tools are easily affordable to even the lowly in society. The main driving force has been that; information has become a commodity – a resource to be utilized efficiently for competitive edge (AMR Research 2004).

Computing and telecommunication technologies have converged to unleash a lot of computing power and communication possibilities that must be harnessed for improving productivity and profitability. The power of the converging technology is what has made the world a global village. Time has essentially been compressed and work content reduced. This has in turn brought on social pressures, which are changing silently, the way work is done, amount of leisure time available, working schedules etc. No one knows precisely where the technology will head in the next ten years but we know for sure that for a long time to come, ICT tools will impact significantly on how we live, how much leisure time is available, as well as social interactions, standards of living, and economic relationships amongst nations.

THE COMPUTER AND THE INTERNET

ICTs are defined by two very important and interconnected components: (a) the computer, and (b) different types of computer and telecommunications networks, among which are telephone networks, Local Areas Networks of computers (LAN), and the Internet. The Internet is itself actually a network of different connected LAN and individual computers.

The Computer

The computer is designed as a general-purpose equipment which can be used for different information collection, conversion, analysis and transfer applications depending on the software that is used with it. In other words, computer equipment is necessary for computing applications, but the sufficient requirements are (i) software (or computer programmes) for processing information (ii) the researcher's knowledge of the different ways a computer can be used to facilitate the different stages of research, and (iii) the researchers skills in using particular software to facilitate the information collection, analysis or reporting aspects of the research process.

In the midst of current developments, the computer has had a central role. Computers are getting to control almost all aspects of our life and work. They are making old methods of work rapidly obsolete. Decisions have to be taken from time to time and computers lend themselves to good use in aiding decision-making because of their speed and accuracy.

Computers have also affected the way and manner information is passed to the user or consumer. They have indeed also helped to facilitate effective communication.

Computers continue to be employed mainly due to the advantages relating to:

- Reduction of computational errors
- More effective control procedures
- Greater degree of systems integration
- Simplification of problem solution by use of software
- Ready supply of information to impact decision making

The Internet

The Internet is simply a computer-based global information system, composed of interconnected networks of computers. It has brought information right to the doorstep of both the rich and the poor. It is cheap to use and deploy within an organization (Microsoft 2003).

You probably have heard about or used electronic mail (e-mail) before. E-mail and related facilities and services on the Internet, such as teleconferencing, telecommuting, and Internet browsing or surfing, are all made possible between offices, organizations, regions and countries through the networking of computers by various types of telecommunications media and equipment, including ordinary telephone lines, fibre-optic cables, satellites, microwave channels, telephone switchboards, modems, etc. Such networking of computers by communications media and equipment is referred to as *Internet* if the network spans the whole world; as *wide area network (WAN)* if it spans an area greater than about 5 kilometers; as *local area network (LAN)* if it spans a small area less than about 5 kilometres; as *intranet* if it connects only the computers of the same organization irrespective of location; as *extranet* if it links an organization's computers to those of its clients; and so on.

Think of the Internet as millions of computers interconnected by the computer and telecommunications net-works of the different countries of the world. Some of these computers are actively connected to telephone lines twenty-four hours every day waiting to attend to other computers, or send, receive, store or forward messages, computer files and other instructions between themselves on behalf of their users. The messages, files and instructions are transferred between the computers in the form of electronic signals through the inter-connecting telecommunications network. The signals are exchanged between the computers much in the same fashion as people exchange telephone calls among themselves.

Computers on the Internet are classified into two main types: servers and clients. Servers are computers that have extensive data processing, storage and communication capabilities, and that can receive and send signals to many other computers simultaneously, and are usually on twenty-four hours a day and seven days each week. Servers are usually perpetually actively connected to one another waiting to receive or send messages and data among themselves. Other computers that lack these capabilities are referred to as clients, and often must connect to nearby servers [usually owned by Internet Service Provider (ISP) organizations] in order to connect to other servers and client computers on the Internet.

ICT IN RESEARCH

Let us begin by considering the following two propositions:

(i) Research basically involves collecting and processing data, and exchanging and using information to improve knowledge;

(ii) Computers, and more generally, information and communication technologies (ICT) are designed for processing data, for exchanging information, and for using information to improve knowledge.

The implication of these two propositions is that ICTs are the quintessential tools for research, and researchers in all fields are expected to arm themselves with the knowledge and skills of how to use them to boost their research productivity. It is also important to reiterate here that the process of research comprises the following four major stages of activity:

(i) Conceptualization of research;
(ii) Design (of the methods of research);
(iii) Data collection and analysis); and
(iv) Reporting of research findings.

ICTs provide appropriate tools for facilitating each of these stages. Our discussion of the use of ICT in research will also be organized around these stages of research activities.

Conceptualizing and Designing Research

The process of conceptualizing and designing research requires the synthesis and application of ideas through communication with different information sources – people, institutions and documents. ICTs facilitate such processes by providing fast modes of communication with people individually and in institutions. Moreover, an increasing proportion of the documents that must be consulted during research is now available in networked computer systems or in computer media such as CD-ROM.

First, communicating with people and institutions might entail using telephone networks to establish contact with other researchers, to establish an active network of field workers during a survey, and/or to actually collect data from people (e.g. telephone interviews), etc.

Second, gaining access to information might entail connecting to the Internet to send and receive e-mail, to browse web sites for information, or download documents for research, or specialized software that can be used for analysing peculiar research data.

E-mail

Apart from personal use of e-mail by people to exchange messages, the e-mailing mode of communication has found important applications in the following contexts:

- *Fast and cheap information service.* E-mail is the next fastest means of communication, after fax. However, e-mail is much cheaper than fax. Moreover, fax communication requires that both fax machines must be active simultaneously for a message to be sent and received. For e-mail communication however, the message might be sent from the originating to an intermediating computer on the Internet. The intermediating computer may then store the message pending forwarding when the intended recipient computer connects to the Internet.

- *Document delivery and data exchange.* An important e-mail facility is the ability to send any computer-created document or file as an attachment to an e-mail message. Hence, large documents containing formatted text, numeric data and images (e.g. logos, photographs, signatures, etc) can be sent by e-mail, much faster than post or courier, and much cheaper than fax.

- *Bulletin boards.* Bulletin boards are computers on which electronic notices may be 'pasted' by other computers by e-mail. Researchers can then use other computers to 'visit' and 'browse' the notices and information periodi-cally. Alternatively such notices may be automatically distributed also be e-mail by the bulletin board to the list of subscribed computers on the Internet.

- *Listserv.* This entails using computer networks to compile and send important notices to subscribers through what is known as a list service or listserv. Researchers can subscribe to different list services pertaining to their areas of research focus, and thereby remain constantly informed of research developments, such as research grants, findings, conferences and meetings, etc.

- *Computer conferencing.* This represents an application of e-mail for the purposes of sending and receiving contributions to a topic. The contributions are sent to a designated 'moderator' computer, which collates and summarizes all contributions, and distributes them to all computers participating in the conference. Such computer conferences often last for a specific period, say three months.

- *Distance education.* In traditional distance education, students and their teachers interact through long distance communication by post. However, in situations where both teachers and students have access to computers, e-mail may be used to communicate instruction, messages, study materials, completed assignments, questions and answers, etc., between teachers and students.

Internet Browsing

We have already mentioned visiting and browsing bulletin boards for information pasted thereon. The Internet browsing facility has also found important applications in the following contexts:

- *Remote logging, and File Transfer Protocol (FTP).* Remote logging refers to the Internet facility whereby a person can use a computer to access and work on another (remote) computer. Working on the remote computer means using any of the software and files on the remote computer much in the same manner as local users of the remote computer are able. Hence, a word processor on the remote computer may be used to edit a report, or a statistical package used to compute data. Files on the remote computer may also be browsed. This facility can be very useful for field workers, or those who may want to work from home (telecommuters), provided they can have Internet access to the server computers of their employers. Also, through remote logging and a procedure called file transfer protocol (FTP), a person may use a computer to copy (download) data files and software from such a remote computer.

- *World Wide Web (WWW).* These represent the most exciting application of the Internet browsing facility. Researchers can use the facility to visit various WWW pieces of information, data files and/or software. One might even register for additional information and other services by completing a form online! The exciting aspect of WWW sites is that they provide both multimedia and hypermedia features. That is, such sites often provide not only textual information, but also images and sound clips along with the text thereby enhancing the visitor's understanding and appreciation of the provided information (multimedia), and usually permit a visitor to browse parts of document in any of several different sequences as desired (hypermedia).

- *Online searching.* This is another application of Internet's remote logging and browsing facilities, which even predates the WWW. The facility permits information searchers to log on to, search, browse, copy or print data in different types of databases - bibliographic, numeric, full-text, and multimedia, either for a fee or free. Each such database may contain hundreds of thousands or more records on books, journals, people, organizations or objects. Access often must be pre-arranged with the database creating or hosting organization.

Finding Information on the Internet

There are many ways to use the Internet to seek and obtain required information. These will now be discussed (Hughes 2004; Cohen 2004).

- Typing in a site address in the window of a web browser to proceed straight to the site. Usually, this takes one to a familiar site or one referenced from the literature or obtained from friends and/or collaborators. The site is explored by following links that appear relevant to the subject area being researched. Usually, good links are designed with short key words that allow one to have an idea of what exists 'beneath' them. Site addresses could also be obtained during implementation of searches using search engines.

- Browsing subject directories, which have been put together for professional (academic) or commercial purposes. The net effect of searching directories is to ignore from the start what may not be so relevant. Since these directories ordinarily contain sorted materials, the time to obtain search results should be shortened. Infomine is a good academic directory maintained by the University of California. Yahoo on the other hand has a commercial focus.

- Using a search engine by entering key words, which relate to the intended subject search. This is perhaps the most popular search mode for starting a research on an area in which one is not too familiar. However, the multiplicity of results obtainable could have a sobering effect. The main reason for the multiplicity of results is the crude nature of the search, which is a poor attempt at indexing. This is expected to be refined as time goes on. Today, Google is used as a good starting point for searches because of its speed. Other good sources of research information are Lycos (*www.lycos.com*), *Alta Vista (www.altavista.com*), and Infoseek (*www.info-seek.com*).

- Searching databases directly helps overcome the loss usually encountered in search engine use. Many of the data and information not usually in the line of the engines could be obtained directly.

- Joining discussion groups helps nurture specialized interests. However one must also be ready for facts and discussion trends that would obviously be off-line as regards specific areas of interest. People with conver-ging interests usually find this a good place to start as many have found useful responses to many bothersome questions and problems.

Some Tips on Conducting Web searches

Each search engine has its own process but a few tips are generally useful for efficient searches. These are outlined below:

1. In formulating key words, ensure that they are relevant or related to the search subject. Where multiple words are to be utilized, determine their logical relationships. This will require whether one is interested where they appear together (AND logic), where either appears (OR logic), where one appears but not the other (NOT logic).
2. To cast a wider net in a search, synonyms may be linked by OR logic.
3. Ensure correct spellings are used for searches. However, whenever they appear obviously wrong, the engine could prompt for correction. But it must be noted that this represents an extra step that could be eliminated by taking time to spell correctly at the beginning.
4. Where results obtained are sparse, it could be worth the while to introduce alternative technical words with similar meanings. It is always good to use different search engines to enable comparative analysis. This may happen more when we are dissatisfied with initial results.

Some caveats on Sourcing Information from the Internet

There is no doubt that the Internet as configured today is a very powerful tool which could be used to facilitate research work, a number of drawbacks should be noted however. These include (Cohen, 2004):

(i) Veracity of information obtained;
(ii) Problems of narrowing down search results;
(iii) Time-to-obtain results.

In reality, the Internet is like a freedom house, which could be visited without notice or appointment. There are no rigid controls. While this freedom is desirable, it has also attracted many freelancers who have no scruples. Many information sites are therefore of doubtful value. There is an obvious need to take extra precautions to crosscheck information obtained from the Internet before using it for any work with serious implications for decision-making.

While the multiplicity of results has the advantage of facilitating comparisons, the sheer number obtained from searches can have time wasting values, due to the need to sift through them to obtain strictly relevant information.

Sometimes the sheer number of results available on the Internet would slow down the time-to-obtain results. However, apart from the number of results obtained, the computer memory and speed also play a role. The smaller these are, the slower the speed. Even when these are not a problem, the Internet traffic and nature of the connection procured also play a part. When traffic is at a peak, then, everyone is forced to slow down a little. However, this is a function of the condition on both the local as well as the International network (Cohen 2004).

Another key point is the dexterity of the user and the logical manner in which the search is permutated. Wrong approaches may bring up nothing, while well-formed queries could bring up thousands of results.

Finally, it is very important to note that there are free access sites and subscription sites on the Internet, with the subscription sites usually containing the authenticated, proprietary and priced information. Clearly, a researcher cannot depend only on the information available at free access sites. In fact, many scholarly journals that a researcher might need to access are now becoming available on the Internet, but at subscription sites.

ICT for Data Analysis and Interpretation

The end process of the data collection stage of research is to collect some data, which might be quantitative or qualitative. Basic sciences are well known for their usually quantitative data. The social sciences have also been emphasizing approaches to research that entail collecting and analyzing quantitative data. Hence, Economists study econometrics, Sociologists now study Sociometrics, and Psychologists study Psychometrics. The humanities are also not being totally left out, as we now have Computational Linguistics, which entail the modeling of the quantitative properties of languages, and Stylometrics, which entail the quantitative analysis of the styles of writing in literary arts. However, even when research data are entirely qualitative, such data, provided they are collected from an adequate sample, can also be analysed quantitatively to identify frequencies and patterns.

Also, long gone are the days when a researcher could envisage analysing his/her research data with just mental prowess assisted by hand-held calculators. As technology has advanced, researchers are now being required to collect greater volumes of data, and to analyse the data with different types of statistical software. However, the effective use of computers for data analysis requires that a researcher understands how to properly organize and process research data.

Characteristics of Research Data

In order to gain a clear understanding of the nature and organization of data for purposes of statistical analysis, it is necessary to understand the nature of an entity group, an attribute of an entity group, and a case of an entity group.

- An *entity* is the group of people, objects, processes, events, etc. that a researcher might be focusing on, say students in a computer literacy class, the snails in a lake, the villages in an area, or the experiments conducted during a period, or the years in the economic life of a country.
- A *case* of an entity group is one specific member of the entity group, for example, a particular student. Researchers often need to collect data on an 'adequate' number of cases of the entity group to enable them to make statistically valid generalizations or inferences.
- An *attribute* of an entity group is a characteristic of the entity group the researcher might be interested in, say the *ages* of the students, the *weights* of the snails, the *populations* of the villages, or the *results* of the experiments, etc. A researcher might collect data on two or more attributes of the entity group to enable him to analyze the relationships between the attributes. Each such attribute is either a variable or a constant.

Preparing Data for Computer Analysis

After data are collected, certain data preparation tasks must be performed before the data can be analysed with statistical software. These are data coding, data entry (or keyboarding), and data entry validation. Care must be exercised in performing these tasks because they are potential channels through which errors might inadvertently be introduced into the data.

Data coding

This is the process of transforming data recorded in one format into numerical or other formats that are amenable to statistical analysis with software. Data coding is usually not required for data that have been numerically recorded with standard measuring instruments, (e.g. the recorded temperature of water in a lake, or the recorded weight of fish). However, coding is often required for data collected through an interview, forms, questionnaire or test. For example, a question and the expected response on a questionnaire might be designed as follows:

Question: How strongly do you feel about the government's deregulation of fuel prices? (Tick only one)

[ ] No Opinion
[ ] Bad
[ ] Between bad and good
[ ] Good

Coding is then the task of converting the actual recorded response to the question (a tick against one of the choices) into symbols that can be easily analyzed with the computer. For the answer categories, the following coding method might be used:

No Opinion = 0;
Bad = 1
Between Bad and Good = 2
Good= 3

If Question was not answered or more than one answer was ticked) = 9

In the above example, there are no hard rules as to the data symbols into which original data might be converted. For example, the codes 'A', 'B', 'C', 'D', and 'Z' could have been used for the five possible answer categories. At times, it might be desirable to code numerical data. For example, a researcher might consider coding the responses to the question "What is your age?" in the following manner:

Less than 2 years	= 1
2-5 years	= 2
6-10 years	= 3
11-15 years	= 4
16-20 years	= 5
21-30 years	= 6
31-40 years	= 7
41-55 years	= 8
56-70 years	= 9
More than 70 years	= 10
(If Question not answered)	= 99

Transferring Data unto Computer Coding Sheets

After data has been collected (and coded as appropriate), the data are usually copied unto computer coding sheets. The purpose of this exercise is to arrange the data on the sheets such that data on each attribute for all the cases are recorded in the same column(s). Data coding sheets are usually divided into 80 numbered columns. Many people skip the use of printed coding sheets, using hand-ruled sheets instead. Some also keyboard coded data from copies of questionnaires direct into computer software. No matter, provided one bears in mind the reason for copying data unto coding sheets, which is to make it easy to keyboard the data into a computer file, and to validate the data after it has been keyboarded.

Data Entry or Keyboarding

The purpose of keyboarding or data entry is to edit and create a *replica* of the data as have been recorded on the coding sheets. The data can be entered directly into statistical software or into a spreadsheet such as Microsoft Excel. Statistical analysis software or a spreadsheet usually features an in-built word processor for entering data into rows and columns. A word processor might also be used to create the data file, but will entail subsequent import of the data into a statistical software or spreadsheet that might be easy or difficult depending on the word processor used. However, if data are first entered into a word processor other than that provided by statistical software, then the data must be saved in a file in the format that the software or spreadsheet can read, usually ASCII or TEXT format.

Data validation

After the data have been keyboarded, it must be validated. First the computer data file is printed. Comprehensive validation can be done by cross-checking all the data on the printed copy of the data with those in the coding sheets. Errors are then flagged so that the data file can be re-edited. However, for very large volume data, comprehensive data validation might prove costly and time-consuming. In such cases, random data validation might be undertaken by checking the accuracy of the keyboarded data on randomly selected cases. This only provides an indication of the general level of accuracy of data entry. Random validation is often also complemented with the use of some facilities of the statistical software to explore the data and highlight obvious coding and data entry errors.

The Data Matrix

The ultimate aim of the data collection, coding, entry and validation procedures is to generate a computerized data matrix to be used for performing various types of statistical analyses, as follows:

Case no	v11	v12	v13	...	v21	v31	v32	... ...	v41	...	...
001	x	x	x		x		x		x		
002	x	x	x		x	x	x				
003	x		x		x	x	x		x		
004		x	x		x	x	x		x		
005	x	x	x		x	x	x		x		
006	x	x	x		x	x			x		
007	x	x	x			x	x		x		
008	x	x	x		x	x	x				
...											
...											

Note: v11, v12, etc are the variable labels or names. Each 'x' represents measured data. Gaps in some cells indicate missing data.

Software for Analyzing Statistical Data

Different software are now available for analyzing statistical data. They can be categorized into two main types: those designed for analyzing most kinds of statistical data, and special purpose software for analyzing data in specialized research fields such as economics, medicine, demography, epidemiology etc.

Software for statistical analysis provide facilities for analyzing data ranging from computing simple descriptive statistics and plotting of charts, to the more complex methods for performing multiple regression, factor, discriminant and cluster analyses.

Software for data analysis include the Statistical Package for the Social Sciences (SPSS), Statistical Analysis System (SAS), Biomedical Programs (BMDP), MINITAB, MICROFIT, PC-GIVE, TIME SERIES PROCESSOR (TSP), EPI-INFO, GENSTAT, SORITEC, STATA, STATGRAPHICS and S PLUS. Some of such software have special functions and are tailored to the needs of specific groups of users. For example, TSP is often used by economists to analyze time series data, whereas EPI-INFO is meant for the analysis of epidemiology data.

Caution in Using Statistical Analysis Software

It must be stressed here that the ability to meaningfully analyse data with statistical software requires more than a knowledge of computers and how to use such software. Statistical software assists a researcher to analyse data with different statistical formulae. Effective use of such software however demands adequate knowledge of the research objectives for collecting the data, nature of the data, and whether the data meets the assumptions of each formula. Thus mere knowledge of the software is not enough, and might, as is often the case, lead to invalid and laughable computations, results and interpretations of the data, such as trying to compute the mean or variance of, say, the gender of members of a sample.

ICT and Research Reporting

Research reporting entails communicating research findings to different audiences through different channels. Among the channels are print, and increasingly, electronic publications, and research meetings such as conferences. ICTs provide tools and systems for facilitating these processes. Among the tools and systems are word processing, graphics and image processing software.

Word processing

This refers to the task of using the computer to edit a text document. Rapidly disappearing are the days when researchers needed secretaries to type or word process their research reports for them. The modern researcher is also, to put it mildly, expected to be a typist, and able to use word processors to compose research reports for dissemination or for publication in print or electronic sources.

Graphics and image processing software

The processing of research reports often also entail having to draw diagrams and graphs, or to manipulate photographic images. ICT now provide different software than can be used to draw such images, more easily or to resize and rotate them, among other possibilities.

Design software

Presentation software. Research findings often also need to be presented at conferences, seminars and other meetings, where facilities for the screen projection of research reports from a computer are often provided. This might require merely projecting parts of the electronic version of a report from a computer unto a screen, or the preparation of computerized slides with presentation software such as Microsoft Powerpoint and CorelDRAW.

Electronic publishing. This is the process of bringing information content into the public domain through publicly accessible computer systems and media. E-publishing is similar to conventional print publishing except that the published content is not printed on paper for distribution, but made available over the Internet, or through CD-ROMs or diskettes. Among e-publishing products are e-books and e-journals.

Institutional and personal web sites: The growth of electronic publishing is a consequence of the rapid developments in computing systems and media, and the growth of the Internet. Increasing availability and popularity of Internet technologies have created great opportunities for researchers to publicize their research electronically through institutional and personal websites.

ICTs for Research in Developing Countries: The Imperatives

In developed countries, and indeed some developing countries, Internet facilities have found extensive uses in library services, commercial information services, education/research, and business generally. Internet facilities are used in libraries for inter-library information requesting (e-mail), document delivery (by the file attachment facility), current awareness services (through bulletin boards and lists), and database searching (online of remote databases). However, publicly-funded libraries are often unable to provide these services effectively due to inadequate funding. Hence, many of the services are now being provided by commercial firms. In education/research, Internet facilities have been used in mediating long-distance computer conferences, discussion and working groups, as well as as long distance education.

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12

INFORMATION AND DOCUMENT RETRIEVAL ON THE INTERNET

A. O. Osofisan

PREAMBLE

The object in this chapter is to examine aspects of information retrieval in research. The various types of information resources on the internet are examined and a classification of the web is also presented. Search methods and search tools are described as well as various search engines for scientific information.

PURPOSES OF INFORMATION RETRIEVAL IN RESEARCH

The purposes of information retrieval in research include the following:

- Constitute bibliographies for precise works
- Search for documentary sources on a field
- Follow the current researches in a given sector
- Collect useful information about a subject

Definition of Information

In the context of research, information is an element of knowledge that can be coded, organized, stored, processed, communicated, and mobilized for useful purposes. This useful information can be recorded in various document types.

Information Resources on the Internet

- Distinction by the applications:
  - Web Servers

- FTP Servers
- News Servers
- Intranets

· Distinction by Visibility

- Visible Web
- Invisible Web

Internet vs Web
The Web is the cornerstone of the Internet but not the Internet. On the other hand, the Internet is a set of tools and applications; these include

· tools for communication;
· tools for navigation;
· utilities for search;
· tools for documents exchange; and
· tools for accessing online services and remote information systems.

The Visible Web
The visible web is a collection of sites for free access, with pages connected between them, but in an unequal way. These pages can be classified into 5 groups.

· Group1: A central core (28%) ultra connected where surfing is easy. Every page is connected with the others by hyperlinks. It is the heart of the network that search engines are going to index in order to follow the proposed links
· Group 2: A group of "origin pages" (21%) that offer links towards the heart of the Web without being indicated in return. These pages are of no interest to Internet users or they are still too recent to be recognized.
· Group 3: A group of "destination pages (21%) accessible from the network but that do not offer returns, such as the commercial sites.
· Group 4: A group of pages with no connection to the heart of the Web (20%), accessible from the origin

pages and giving access to the destination pages
- Group 5: A group of Web pages without links with the other pages (10%)

The Invisible Web or the Deep Web
The invisible web (or deep web) comprises of the following:
- Sites built around a data base searchable only by an internal engine
- Sites offering a consultation by subjects but needing user identifier to log in: numerous scientific sites
- Sites composed of files in formats that the web robots cannot recognize
- The different data banks hosted by commercial scientific servers (Questel-Orbit, Dialog, STN, etc), accessible by subscription
- The web pages which contain the tag [no robot]

Visible/Invisible
Points to note
- Search engines index partially the visible web
- The volume of visible web is much less important than that of the invisible web
- The richest sites for research belong to the invisible web
- There are specialized tools and skills which allow users to identify and seek the invisible web or the sites of the "deep web".

DOCUMENT TYPES
- Dictionaries and encyclopedia
- Books
- Articles
- Reports, Studies, Press kits
- Dissertations and Theses
- Maps
- Audio-visual documents:films, videos, photos, slides
- Data banks
- Mailing lists, news groups
- Bibliographies

Where to find the Documents? All documents can be found on the Internet (Visible and Invisible Web).

The Choice of Documents
The choice of documents depends on:

- The purpose of the search
- Needs in information
- Available resources
- The relevance of these resources

SEARCH METHODS
Three methods of search can be identified, and they include:

- search by successive menus: from main subjects e.g (www.yahoo.com);
- search by a keyword in an index which is often constituted by all the words of the full text e.g. www.altavista.com , www.google.com;
- the search by nodes: proposed by sites which work as access points to the domain of search or starting points. Thematic portals (or gateways) e.g the catalog of search engines www.beaucoup.com

These search methods are sometimes combined.

Classification of Search Tools (Search Engines)
Definition
A search engine is a data bank, with an associated software for information retrieval.

Classification

- Directories
- Indexers or Robots
- Meta-Search engines
- Intelligent agents

Directories

- Thematic guides offer lists of resources selected and classified by categories (or subjects) and sub-categories.
- Directories and catalogues are organized often in

alphabetical order. They supply addresses of services, documents, institutions and members.

- Guidance or orientating sites: they propose marks and starting points for searching.

Indexers or Robots

- Organize the retrieved information and then index all the information: the titles, summaries, the URL addresses, and sometimes the contents of the documents.
- Use operators for search. Offer two search modes - simple and advanced.
- May be thematic or specialized.
- Examples are
  - *http://www.google.com ,*
  - *http://www.altavista.com,*
  - *http://www.alltheweb.com and*
  - *http://www.lycos.com*

Meta-Search

- Mobilize several engines. In a single operation, several sources of data banks are searched.
- Meta-search tools represent the first generation of the intelligent agents. They present results by degree of relevance and delete duplications.
- Examples Metacrawler www.metacrawler.com
  Profusion www.profusion.com (advanced search)
  Search-Com www.search.com
  Ixquick www.ixquick.com etc (Dogpile, Kartoo…)

Intelligent Agents

The intelligent agents can be classified into first generation, second generation and third generation.

First generation

The first generation agents are essentially Meta-search tools that enable alert setting. The found document can be downloaded for an offline consultation and the queries can be updated. They are either passive or active.

- Passive: Dogpile www.dogpile.com

- Active: TracerLock www.tracelock.com
(make queries and store questions)

Second generation
The second generation agents are high-level software. We can apply them on the results of the search operations such as deletion of duplicates, the memorization of the search steps and set alert on a subject. The found documents can be downloaded for an offline navigation and the queries can be updated.

Examples:
Copernic www.copernic.com/download/index.html,
Webseeker www.bluesquirrel.com
Wisigot www.wysigot.com

Third generation
The third generation agents are endowed with linguistic and semantic tools, and can be interrogated in natural language.

Examples :
Autonomy www.autonomy.com
SemioSkyline www.entrieva.com/entrieva

Search Engines for Scientific Information
- OJOSE: Online Journals Search Engine www.ojose.com
- SCIRUS, www.scirus.com
- PHIBOT, www.phibot.org
- SCISEEK www.sciseek.com

Catalogues Sites
Access to documents- collective catalogs, books exchange service, on-line documents supply, full text documents download.
- SUDOC www.sudoc.abes.fr covers 2900 institutions
- Bibliotheca Universalis, Uk www.bl.uk/gabriel/bibliotheca-universalis

Documentation Services
The resources of university libraries are accessible from a unique portal mentioned on the home page of the university sites under

the columns "Resources" or "Centres of resources"

Example

In Bordeaux, 18 catalogues are gathered in the collective documentation service www.babord.u-bordeaux.fr

Other Resources

Catalogues of the big libraries, the documentary services, national bibliographies etc

Examples:

- Portal ABES www.abes.fr
- Patrimonial repository libraries www.bnf.fr
- European libraries Gabriel www.bl.uk.gabriel/
- National Library of France www.bnf.fr
- Collective catalogue of French public libraries www.ccfr.bnf.fr
- Museums and Archives http://www.culture.gouv.fr/
  - The French Academy http://altif.fr (dictionary and full text bank)
  - The European Commission
  - The EuroDicAutom: http://europa.eu.int/eurodicautom

Other banks of projects include:

- Debates and exchanges arena
- newsgroups and mailing lists.

FURTHER READING

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13

WRITING A PhD THESIS

Olayinka, A. I. and Oriaku R. O.

DEFINITIONS

Thesis

The word 'thesis' is a common term so well rooted in scholarly talk and presentations that one often wonders if the meaning is as universal as it sounds. Thesis simply means "a dissertation resulting from original research - especially when submitted for the award of a degree or diploma". It is a complete record of the research done for a postgraduate degree. The emphasis is on originality and research (hypothesis, idea, line of argument).

Research

Research is another word that academicians constantly use in various contexts. It can be summed up as "a systematic investigation to establish facts aimed at increasing the sum of knowledge" [*Chambers English Dictionary* 1990) and the *Collins Dictionary* and Thesaurus 1992)]. Doing research involves three main steps, namely:

- Starting research,
- Managing research, and
- Reporting research.

Starting Research

Starting research involves the following:

- Clarifying research problem;
- Establishing research objectives;
- Formulating research questions;

- Outlining research methods;
- Conducting literature review; and
- Drafting a concept proposal.

Statement of the Problem

There has to be a description of research topic. This will include:

- Background information,
- Evidence/prior research.
- High priority, and
- Magnitude of the impact.

Research Objectives

The research objective deals with the question "what is to be achieved through research?"

- Provide basis for detailed design of the research;
- Allow evaluation of the research; and
- Provide criteria to measure the outcomes.

The general objectives give the overall aim of the research. There should be only one or two. On the other hand, the specific objectives are the concrete processes in the research, which are directly addressable by the methodology and which are followed in order to achieve the general objective(s).

For example, the general objective in a doctoral thesis could be to examine the fundamental determinants of the real exchange in Nigeria, while the specific objectives are to:

- analyse the determinants of the real exchange rate in Nigeria,
- assess their relative effects on real exchange rate, and
- evaluate the effects of alternative policy measures on the real exchange rate (Yekini 2004).

Research Questions

Research questions are derived from the research objectives. They provide direction of the research methods, i.e.

- hypothesis tests
- data requirement/acquisition
- data analysis

Questions should be about size or magnitude, order, probability (error and bias), relationship or causality.

Research Concept and Framework

The various dimensions of research include among others the following:

- Examination/investigation
- Experimentation
- Exploration
- Fact finding
- Groundwork
- Inquiry
- Probing
- Scrutiny
- Analysis

It is, therefore, implied that the framework of a sound research will include the following:

- adequate experimental design and conceptual framework;
- adequate knowledge of previous work carried out by other workers in that field of study;
- competence in executing the proposed concept or research process;
- orderly data collection which may involve bench work, clinical tests, the use of well authenticated questionnaires (instruments) etc.;
- analysis of data to pave the way for a balanced interpretation of the results;
- a sound argument and presentation of the emerging facts to highlight the specific nature of the contribution of the research to knowledge.

WRITING A THESIS

How do I know what I think
Until I see what I say?

-E.M. Forester, in Scott and Garrison (2002:17)

This quotation reminds us that any form of writing is basically an act of communicating not only with others but, perhaps more importantly, with ourselves. In other words, writing is one of the best ways by which we learn. The common notion that we write in order to indicate what we already know, or that learning ends when we begin to write for the benefit of the reader, does not totally reflect reality. On the contrary, we continue to learn even as we write, often coming to a new understanding of our subject.

> I believe in miracles in every area of life except writing. Experience has shown me that there are no miracles in writing. The only thing that produces good writing is hard work.
>
> *I. S. Singer, in Lunsford and Connors (1992).*

The second quotation reminds us of the obvious but often ignored fact that writing is 90 percent perspiration and 10 percent inspiration. Taken together, the two quotations remind us of what we need to do as we set out to put pen to paper to report our study or the accompanying abstract. These include the following in a general sense (Scott & Garrison, 17-21).

When you set out to write:

- Remember that you learn by writing.
- Challenge yourself – Remember that writing is a struggle.
- Remember: everybody has writing skills. Yours will get better the more you use them.
- Maintain enthusiasm for your work.
- Challenge yourself; think usefully about your topic.

As you keep to these rules, it is important to note that all aspects of thesis writing, including abstracting, seek to do two things: they seek:

- to inform and
- to persuade

Emphasis in the blend shifts from one goal to the other as the writer moves from one task to the other.

Elements of Persuasive Writing

The goal of informative (or expository) writing is simply to impart information about the subject of investigation. Persuasive writing seeks to convince the reader of the author's particular point of view or to influence the audience's opinion. Obviously, this can be done only through a careful blend of substance or content (information) with form or style of communication. Key elements here include the following (Scott & Garrison, 22-28).

- Define your purpose.
- Know what you want to say and keep an eye on your own biases.
- Define your audience.
- Be inventive in the discovery and recovery of what you already know about your topic.
- Do not wait for inspiration – always set time limits for yourself.
- Brainstorm with yourself – compile all ideas that occur to you on the topic as quickly as possible.
- Organize your thoughts.
- Be flexible as your writing progresses. Do not be a slave to your initial assumptions.
- Stay objective and self-critical.

With the concept of a research at the background, the first step in writing a thesis is the choice of a title. This title should be clever, brief and thought-provoking. Examples of carefully-chosen PhD titles in the University of Ibadan as considered and approved by the Executive Committee of the Postgraduate School in January 2005 are given below:

Original title	Modified title	% reduction	Reference
Lucan teaching on the poor in the context of the Redeemed Christian Church of God's programmes for the poor in Lagos (Word count: 21)	The Redeemed Christian Church of God's programme for the poor in Lagos in the context of Lucan Teaching (18 words)	14	Oguntoyinbo-Atere (2005)
Customary land law in south-western Nigeria: relevance and need for wider application (12 words)	Evolution, development and travails of customary land law in south-western Nigeria (11 words)	8	Adekunle (2005)
Globalisation and labour: a case study of the Nigerian Labour Congress (11 words)	Globalisation and the Nigerian Labour Congress (6 words)	45	Adenugba (2005)
Outcome of reproductive health educational intervention on drop-out rate due to unwanted pregnancy among selected rural secondary school students in Osun State, Nigeria (23 words)	Unwanted pregnancy and drop-out rate among rural secondary school students in Osun State, Nigeria (14 words)	39	Adegbenro (2005)

It can be observed that in each case the modified title is shorter and more concise than the original title.

Put together, therefore, to write a dissertation based on an original idea in a chosen field, that is systematically packaged to enhance the body of knowledge is not a trivial job. The "writing-up" is mainly a compilation of and presentation of the emerging new facts from the research. This write-up must have a focus in which are embedded the following:

- New knowledge,
- Understanding and appreciation of the field of study.
- Critical analysis of related work (as it relates to the field of study).
- A package information designed for the benefit of the reader and not for the writer
- A footnote to point out the direction that the work will go from where the candidate has stopped.

The hallmarks of writing a doctoral thesis include the following:

(a) Have a "thesis" of the thesis. A doctoral thesis should be summarized in at least one sentence. This avoids long, tortuous repetition which ultimately confuses the candidate.

(b) Clearly define the research problem at a very early state in the research process and find the solution as the thesis is written.

(c) Start writing a first draft early, based on preliminary conceptual maps. This will need revising, editing and re-writing. This editing/correction helps the supervisor convey a message to the candidate right from the outset.

Layout of a Doctoral Thesis

The ultimate aim, however, is to:

1. present the hypothesis and research problems that have arisen probably from previous works,
2. highlight the results of the methods employed in tackling them,
3. present the results of the method employed,
4. interpret these results in the light of the new solutions and/or findings,
5. conclude the research based on the results, bring to the fore the problems yet unsolved and proffer the way forward.

A typical outline of a doctoral thesis is shown below:

Questions/issues to be addressed	Chapter/section of thesis
Why am I doing it?	Introduction / Significance
What is known? What is unknown?	Literature review Review of research / Identifying gaps
What do I hope to discover?	Aims
How am I going to find it?	Methodology
What have I found, and what does it mean? Or what do they mean?	Results Discussion
So what? What are the possible applications or recommendations? What contribution does it make to knowledge? What next?	Conclusions

This layout sums up the thought process and arrangement of facts. It may be followed in this pattern in some disciplines or it could be implied as it provides for easy sequencing and logical reasoning.

Abstract

An abstract is a summary (usually not more than 500 words) of the contents of a thesis or any other document. An abstract, by definition, is both informative and persuasive.

The dos and don'ts of abstract writing

- Stress content and not intent in a four-part outline indicating:
  - The principal objectives and scope of the research (What was done? Why was it done?).
  - Methodology (How was it done?).
  - Results (What was found?), and
  - The principal conclusions (Significance of findings?).
- Assume your reader is knowledgeable.
- Avoid the use of passive voice.

- Keep the abstract short.
- You can name authorities but make no reference to specific literature.

An Example of a well-written abstract is shown below (Yekini 2004)

ABSTRACT

There has been persistent depreciation of the naira exchange rate since the mid-1980s. Although the monetary authorities have implemented various policy reform measures, a stable exchange rate is yet to be achieved. Against this background, the study examines the fundamental determinants of the real exchange rate in Nigeria. The specific objectives are to: analyse the determinants of the real exchange rate in Nigeria; assess their relative effects on real exchange rate; and evaluate the effects of alternative policy measures on the real exchange rate.

Compared to previous research, this study breaks new ground by evaluating the effects of such fundamental determinants as measures of capital flow, domestic capital accumulation, price of crude oil, etc. and by carrying out a simulation exercise aimed at gauging the effects of policy changes.

This study used a macroeconomic model composed of six equations. Ordinary least square technique was employed for the estimation of the model equations over the period 1970 to 2000. This enabled the study to cover the policy shifts over the periods before, during and after structural adjustment. A simulation exercise was also conducted to test the effects of alternative policy measures on real exchange rate. The simulation exercise was conducted using nominal exchange rate, aggregate credit and domestic capital accumulation based on government policy targets. These policy targets were based on the macroeconomic environment in the respective fiscal years. Time series properties of the variables used in the model were examined. Further, long run properties of the variables were examined. The existence of co-integrating relationship informed the estimation of short run dynamic model.

The results revealed that the major determinants of real exchange rate are terms of trade, government consumption of non-tradables, domestic capital accumulation, growth in domestic credit, capital flow, nominal exchange rate, technological progress and crude oil prices. The terms of trade are negatively related to real exchange rate at 5%level, and this is an indication that improvement in terms of trade leads to appreciation of real exchange rate. Also the effect of oil price on real exchange rate movement is negative at 1% level. This shows that increase in crude oil earnings leads to appreciation of real exchange rate.

Further, the results reveal that improvement in capital inflow will appreciate real exchange rate while nominal exchange rate appreciation leads to appreciation of real exchange rate. The in-sample simulation results show that nominal exchange rate depreciation leads to the depreciation of real exchange rate, while growth in domestic credit leads to appreciation of real exchange rate. The out-of-sample simulation results show that growth in these variables leads to depreciation of the real exchange rate.

The overall lesson from these findings is that the design of fiscal and monetary policies (which affects some of the significant determinants of real exchange), and their implementation should be more consistent and effective if persistent depreciation of naira exchange rate is to be addressed.

Keywords: real exchange rate determinants, macroeconomic policy reforms, Nigeria
Word count: 480

Introduction
What is the topic and why is it important? State the problem(s) as simply as you can. Remember that you have been working on this project for a few years, so you will be very conversant with it. Try to step back mentally and take a broader view of the problem. How does it fit into the broader world of your discipline?

The introduction should contain information on the following issues:

- Background to the research
- Research problem and hypotheses

- Justification for the research
- Methodology
- Outline of the thesis
- Definitions
- Conclusions

Literature Review

What is literature review about?

- Literature review serves as the source of specific knowledge, research topic, conceptual framework and research methods.
- It is all about conducting information search to solve a research problem.
- It acts as a bridge between what is known and unknown about the research problem.
- It is a vehicle for illustrating why and how the study can be carried out in terms of methodology and the current state of knowledge in the problem area.

The literature review should contain only prior research works and advanced materials. Review of basic theories is a pre-requisite for the research not a part of it.

Sources of Literature

The sources of literature in a research will include the following:

- Theses, dissertations
- Journals
- Academic working papers
- Advanced textbooks or monographs
- Encyclopedias, Handbooks.

The following guidelines are useful in preparing a literature review. These are not to be followed question by question, but the researcher should let them simply inform his/her thinking.

- What issues does the writer regard as pertinent?
- What seems to be the purpose of the article?
- What assumptions about the topic or theory seem to

underlie the article?

- How do these assumptions compare with the assumptions of others who have studied the same topic from other perspectives?
- What is the value of this approach i.e. in what context might this approach be useful?
- What sort of methodology did the scholar use?
- What is your assessment of the article?

Questions to be addressed by the literature review section

The literature review section of a PhD thesis should address the following four questions:

- Where did the problem come from?
- What is already known about the problem?
- What are the methods used so far to solve the problem?
- What suggestions do previous studies recommend for further studies?

A robust and insightful literature search that provides answers to the above would not only enrich the understanding of the researcher in relation to the research problem but also enables him/her to avoid the mistakes of previous studies.

Case Study

For example, a thesis on Democracy, Governance and Human Rights in Africa grouped its review of literature into the following sections: (Has s/he answered the four questions above?)

(i) Decentralization in African History: sketches the development of decentralization and thus trying to answer the question, 'where did the problem come from?'

(ii) Why decentralize? Examining various justifications behind decentralization reforms. The section is also based on the review of literature in order to answer the question of the origin of decentralization.

(iii) Dimensions of decentralization: Here the review looks into how decentralization is being structured around actors, powers and accountability relations. In other words, the section is reviewing literature in order to answer the question on what is already known about the problem.

(iv) Implementation of decentralization. Here the various methods used so far to solve the problem of decentralization in the literature are explored including the enabling environment, planning, oversight etc.

(v) The last section of the review sets research priorities based on the gaps in knowledge identified in the previous sections.

Problems with Some PhD Theses

- Unfortunately, the reviews of literature section in most doctoral theses are often clumsy, make dull reading and are excruciating torture for most examiners and readers.
- If the review section is well written and documented it may be publishable with few editorial work and possible updating.

Matters Arising

- Indeed some journals such as the *Review of Educational Research* are exclusively devoted to such critical retrospectives on scholarship.

- Therefore, there is the need to provide some useful tips on how to write a good literature review section of a doctoral thesis.

Useful Tips on How to Write Literature Review Section of a Doctoral thesis

- Keep up with the literature in your area of study and make notes about important papers throughout the duration of your doctoral programme.

- Read extensively in the area that either is directly or indirectly related to the topic of study. When you read about a topic related to your area of study, write down the following about what you have read. The title, author(s), year, volume and pages.
- Make a concise summary of the main arguments in the literature you have read in your own words.
- Do not concentrate on research findings when reading research articles, thus overlooking valuable information on methods etc.
- Whatever arguments must be sustained in the review of the literature, there is no place for "Adeogun says this…" and "Livingstone says that…".
- Such paragraph-by-paragraph recital makes the literature review section very boring to read and has the tendency for dulling the senses. Note that a literature review is not just a catalogue of works.
- Make sure you read relevant papers about your likely examiners or potential employers.
- There is no limit to the number of papers to be included in this section but all relevant papers read must be included in a logical order depending on the purpose of study. For example, the review could be approached chronologically so that the trends in the development in the area of research could be followed.

Last part of the Literature Review section

In most cases, the concluding section of a review should be able to identify the gap in knowledge the doctoral student intends to fill.

Methodology

The methodology section of any doctoral thesis, whether it is an empirical research or not, must be able to answer the question '*How am I going to do it*?'. This section describes the ways the study was carried out, the instruments used and the analytical techniques used in the data analysis. It is the easiest section of the thesis to write because it usually contains the writing down of what the researcher did and how he did it. In most science-based disciplines it is an important section because the methodology selected for a particular research determines to a large extent the quality of data obtained.

Issues to address in Presentation of Methodology
The issues to be addressed in the section on methodology include the following:

- The research design
- The sources of data (primary, secondary, archival etc.)
- The procedure for collecting the data, and
- The analysis of data.
- In general, the methodology section of a doctoral thesis must provide a step-by-step set of procedures used for conducting the investigations. The section must be written carefully, formally and in a logical order.

For most science-based and other empirical research, the methodological section must contain the following:

- identification and description(s) of the target population and sampling technique used;
- presentation of instruments and techniques for measurement;
- presentation of a design for the collection of data;
- presentation of procedures for collecting and recording data;
- explanation of data analysis procedures used; and
- development of plans for contingencies such as subject mortality.

Results and Discussion
There are two major modes of presentation of results:

- the pictorial and
- the rhetorical.

The mode of presentation of results will vary from one discipline to another, from one research subject to another. The presentation of results in Economics is likely to require the use of tables, graphs and diagrams; a thesis in Literature or Religious Studies is less likely to contain these. [Sometimes the pictorial and rhetorical modes are used together because they are mutually supportive.]

- To begin with, you need a thesis statement to enable you organize your results into a coherent body of information.
- The thesis statement is an encapsulation of the details to come and the point of view of the researcher. [Having a thesis statement helps you maintain focus on your research objective. The thesis statement could change or be modified several times in the course of the writing of your draft(s) as fresh problems and insights emerge.]
- Whatever is irrelevant to the thesis statement may distract you or weaken your discussion in the text; it should therefore be left out of the text. [This is often difficult for researchers because of the impression they stand to make with the accumulation of data. Such a sentimental attachment to data should be avoided by the researcher. He/she should be consoled by the fact that such materials which are left out are not necessarily useless; they could ultimately form the kernel of other/postdoctoral publications.]
- Results should be presented logically, if your points are to be made effectively.
- For [you to achieve] coherence [which means *sticking together logically*] (White 267), you need to follow your outline. In that regard, the items should be arranged with regard to their connectedness. This will require that you organize them under sub-headings. Find the connections between the sub-divisions to arrive at the coherence of the whole presentation. [To enhance coherence and fluency of your paper "you may need to add transitions (bridges) between sentences and paragraphs or to define connections or contrasts" {Gibaldi 40}]

Organizational Plan

- In discussing your results, decide on and always keep in mind the method(s) you intend to use in your presentation. This should be considered when you are drawing the outline of your thesis. That is to say that your outline will be determined by a consideration of your set objective and the approach by which you intend to get there.

- Do you want to define? To define something entails setting boundaries or limitations. A *categorical* (dictionary-type of) *definition* requires that the item to be defined be identified as belonging to a certain class and is then distinguished from other members of that class. The advantage of this is that it makes for brevity and detachment. You could then go from this type of definition to a stipulative definition which goes beyond "the general meaning of the subject (item) to include *particular* insights or applications based on the writer's own experience or reasoning." This "places emphasis on the writer's individual insights and experience with the subject in question" and enables him/her elucidate and illuminate a concept. Writers frequently use *operational definitions* whereby emphasis is moved from what the subject/item ***is*** to define what it *does*. There is also *lexical definition* whereby the writer examines the nature of the word itself, supplying its etymology (theoretical or known origin) and possibly the evolution of its usage. For instance, a lexical definition of microscope would call attention to its derivation from the Latin word *micro* (Greek, *micros*), meaning 'small'; and from the Latin word *scopium*, which was derived from the Greek word *skopein*, meaning 'to see'.

- **Narrate:** This involves the principle of storytelling, the presentation in the form of a story of personal experience which is true, or of fiction, invented experience which gives the impression that it *could* be true. "Narration plays a vital role in informational writing… It is the rhetorical technique that conveys the history of the subject at hand." "Since every subject has a history, historical narration is relevant to every subject.

without exception." Illustrations (tables, diagrams, charts, maps, etc.) present data succinctly even pictorially and so are interesting, even absorbing, but their effectiveness is enhanced when the same data are presented in an even more absorbing manner, as in a story. They make for greater involvement of the audience/ reader than illustrations do.

- **Describe:** Description has an evocative power which "enhances a reader's involvement with the subject/ material." This "makes it an important rhetorical technique for conveying information." It may be used to enhance the reader's "understanding of a natural phenomenon or process." Description may include comparison: How is X similar to Y? How is X dissimilar to Y? Descriptions that answer such questions contribute to a broader understanding of the subject at hand].

- **Classify:** This is a way of defining a subject by placing it in a category or class, before going on to distinguish it from other members of that category/class. As a rhetorical technique, classification puts emphasis on the logical principles that reveal why the item in question belongs to one category and not to another. For example, living organisms are classified into family, genus, species, order, class, phylum, kingdom, etc. Such a classification scheme simultaneously identifies an organism by its genus name and its species name, as well as demonstrates its relationship to other organisms.

- **Divide:** This is another way of defining a subject/ material by identifying its constituent parts, thus providing additional insight into its nature. For example, one can classify a tree by species - palm, oak, *iroko*, etc - even by subspecies – date-palm, oil-palm and raffia-palm etc. But a particular tree is also talked about by dividing it into its parts: root system, trunk, leaves, etc. Usually these parts are referred to in terms of their "*interrelationship* into an organic whole."

- **Argue:** Argument is necessary when one seeks to validate or contradict an existing idea or position, often with the aid of supportive data. In other words, to argue entails providing reasons to show that something is true or untrue. In adopting this method, the onus is on the researcher to convince the reader about the validity of his stated position. When you argue, strive to convince your reader that your stance – especially on a controversial issue – is more sensible, more beneficial, and more ethical perhaps than the position taken by those with opposing views(White, 160-1), hence the emphasis on logicality of presentation.

- **Analyse:** A subject/material may be defined and classified, its appearance and function/value described and its historical background told but the reader would still not understand its process. This problem is solved by analysis which entails probing the nature of the subject with a view to determining how or why it works. The nature of a rock, its constituent elements, history, will not alone tell us *why* there is the phenomenon known as earthquake or *how* it occurs. But by describing the tensions inherent in the history and composition of the rock and the interpenetration between these and the larger environment a process is initiated which leads to earthquakes or volcanic eruptions, etc one is stressing cause and effect. This is the stuff of analysis. When the subject is technical, rare or exotic, the analyst uses analogy: a comparison between the subject or phenomenon being analyzed and an object or phenomenon which is considered to be much more familiar to the reader. The use of appropriate and vivid diction facilitates analysis. An analytic write-up on a given subject identifies and describes the parts of that subject and then goes on to show how the parts interact to create the whole (White 111).

Organizing Principles

- Depending on what the subject of the research is, any of the following principles could determine the structure and effectiveness of the presentation:
  - **Cause and effect:** This stresses the relatedness of things, enhances understanding of a process and the idea of organism or sense of system.
  - **Chronology:** This stresses order (natural order/ sequence) with regard to time and is linked with cause and effect.
  - **Logic:** This could be a deductive line of argument which moves from the general to the specific {e.g. from corruption in the Nigeria Police Force to the shooting of recalcitrant drivers at police checkpoints). An inductive line of argument moves from the specific to the general (e.g. from the shooting of recalcitrant drivers at police checkpoints to corruption in the Nigeria Police Force).
- Where empirical investigations, physical surveys and computations are carried out the data generated are presented as illustrations in the form of diagrams, tables, graphs and charts.
- Sometimes illustrations are given as maps and photographs.
- The illustrations to be used should be assembled and arranged in the order that the researcher is going to use them.
- When they are required, such charts, maps and photographs are selectively presented. Figures which repeat data need not be used more than once. However, the frequency of recurrence should be noted and explained.
- Minor variations in the available charts and figures should be summarized rather than be included. The significance of such variations should be noted and explained.
- Details contained in the charts, plates, maps, or figures do not have to be restated in the text.
- Scales of and keys to maps should be indicated to

facilitate the reading of these. Axes and other keys to the reading of graphs/charts etc should be given. Any magnifications of plates and appropriate units of measurement should be stated.

- Indicate explanatory footnotes by placing standard footnote reference markers (*, +, #) after words or numbers of the illustrations (Figures and Tables) they refer to.
- Binomial names of plants and animals should always be italicized or underlined.
- Always be mindful of your objective.
  - Are you aiming at breaking new grounds?
  - Are you expanding the scope of an existing position?
  - Are you persuading your audience to accept a position?
  - Are you explaining, describing or arguing?
- Relate your results and discussion to the literature review.
- A discussion of the results should take into cognisance the conditions under which they (the results) were obtained.
- Be mindful of your audience – its composition, specialization, etc.

The various methods are not mutually exclusive but reinforce one another.

The presentation of results and the discussion that goes with it require painstaking attention to details, relevance, relationships. Usually several drafts are made in the course of re-evaluating past work or positions held, revising the conclusions, and the general worth or validity of the study. These drafts need to be preserved separately, at least until the study is presented officially and approval is given to it. The availability of the computer and word processing make revisions less cumbersome.

Final Chapter, References and Appendices

Conclusions and Suggestions for Further Work

A summary of conclusions is usually longer than the final section of the abstract, and you have the space to be more *explicit and more careful with qualifications. You might find it helpful to put your conclusions in form of points.*

Many researchers hesitate to impose their interpretations and conclusions on the reader, especially when they pertain to the significance of their results. Unfortunately, without them, the reader can only wonder why he read the thesis. Examiners in particular are unlikely to ascribe any more significance to a thesis than the author gives it. The conclusions section should include:

- The principles, relationships, and generalisations inferred from the results (but not a repetition of the results),
- Any exceptions to or problems with these principles, relationships, and generalizations as indicated by the results,
- Agreements (or disagreements) with previously published work,
- Theoretical implications and possible practical applications of the work, and
- Conclusions drawn (especially regarding significance), with a summary of the evidence for each conclusion.

It is often the case with scientific investigations that more questions than answers are produced. Some of the questions or issues that can emerge, under the discussion of recommenda-tions for further work, include:

- Does the work suggest any interesting further avenues?
- Are there ways in which the work could be improved upon by future workers?
- What are the practical implications of the work?

This chapter should usually be reasonably short—a few pages perhaps. As with the introduction, it is a good idea to ask someone who is not a specialist to read this section and to comment.

References

The style of referencing is described in detail in Chapter 10 of this book.

Acknowledgements

All those individuals and institutions who have contributed to the success of the research should be thanked, but this section of the thesis should be brief.

Appendices

If there is any material that should be in the thesis but which would break up the flow or bore the reader unbearably, include it as an appendix. Some things which are typically included in appendices are:

- important and original computer programmes,
- data files that are too large to be represented simply in the results chapters,
- pictures or diagrams of results which are not important enough to keep in the main text, and
- research instruments

SUMMARY

Causes of failure of a thesis

- poor presentation / writing / communication
- 'unoriginal research'
- wrongly conceived topic
- poor structuring of an argument
- inadequate bibliography
- poor supervision

In writing your thesis, prepare *a first draft* that includes all the

- data,
- arguments, and
- conclusions which you had planned to cover.

Then, edit your manuscript carefully. From the reader's point of view;

- Is the text clear?
- Are the figures thoroughly integrated with the text?

Go through this process at least twice, having a new draft typed each time. When you are satisfied, test your success on a colleague, preferably one who is not well acquainted with the subject matter. *Be prepared for criticism*. If one reader does not understand parts of your text, others will have the same problems. Remember, you are thoroughly acquainted with your subject; your reader is not.

Remember that "*Good writing will not save a bad idea, but bad writing can kill a good one*".

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THE UNIVERSITY OF IBADAN MANUAL OF STYLE (UIMS) FOR THESIS WRITING

A. Raji-Oyelade, E. O. Olapade-Olaopa & T. O. Alonge

INTRODUCTION

A Manual of Style can be described as a collection of *guidelines* for the *graphic representation* of ideas, essays, journals, books and other materials consulted in the course of an academic *research*. The reference manual is the method of bibliographic documentation for any organized form of scholarly writing. It is otherwise called Style Sheet, Style Guide, the Reference Manual, or the Citation Format.

Among other values, the citation of previous, significant, related, controversial or relevant works in a research work

- acknowledges the importance of those investigations,
- serves as the evidence of the researcher's knowledge of existing materials on the subject of current enquiry, and
- provides the reader with more details and traceable information on the subject of investigation and analysis.

Responsible use and referencing of all sources is a necessity. It is important to note why this section of academic writing should be treated with painstaking care and with an eye for proper details. We acknowledge ideas, facts, and any material at all, from others because:

- it is *honest* to do so;
- it can give *authority* to our work; and
- it promotes and provokes *further research.*

However, to be of real value, all references must be readily accessible to the reader.

FEATURES OF THE UNIVERSITY OF IBADAN MANUAL OF STYLE

This guide is designed to assist graduate students, researchers and scholars in the preparation of articles, theses and dissertations in all the disciplines in the University of Ibadan Postgraduate system. In simplifying and creating a University of Ibadan Manual of Style (*UIMS*), effort has been made to sustain the import of the standard citation and to retain the universal ideals of clarity and detail which any reference format must meet.

The ultimate objective of the guide is to achieve consistency in the presentation style of academic writing. As a composite simplification of some standard Style Sheets, this unified style of referencing is hereby recommended for all graduate students and scholars involved in seminars, symposia, examinations and allied research for submission within the University of Ibadan Postgraduate system. Therefore, the use of Style Sheets other than the *UIMS* in formal academic discourse is not acceptable.

The *UIMS* will be available for review and any other emendation after every fourth consecutive year of operation.

BIBLIOGRAPHICAL REFERENCING

Bibliographical referencing is usually inserted at two or three points in a presentation: as *quotation* in the body (chapters or main divisions) of the study; as *auxiliary notation* (footnotes or endnotes marked by the use of superscripts) in the body or at the end of each chapter of the thesis (wherever applicable); and as *full citation* where all materials consulted are organized and listed at the end of the thesis. Perhaps no other section of a manuscript requires more time and effort for corrective editing than does the reference section. Therefore, for the reason of proper documentation of consulted materials, the researcher is implored to be meticulous in compiling his/her list of references using the acceptable standard Style Sheet.

BASIC INFORMATION ON CITATION WITHIN THE TEXT

- Materials of other scholars could be referenced by the use of *direct quotation*, by *paraphrasing*, or by *summation* of the cogent and relevant points within the text.
- The most important items for usual mention in the process of narration, explication, or analysis are the names of authors, the years of publication, and the pages where quotations are drawn from. The title of essay or book may be noted in the course of presentation.
- The name of the author should be followed by the year of publication in parenthesis.
- When the author's name does not form part of a preceding sentence to a quotation, the reference (including name, *COLON*, title/year of publication, *COMMA*, and page) is made at the end of the quotation, all in *PARENTHESIS*.
- After initial presentation, subsequent references to the title of a work (e.g. anthology, collection, edited book) may be given in shortened form. For example, *Black feminisms in a multicultural age* can be shortened as *Black feminisms.*
- When two authors of a cited work are named in the text, they are joined with the use of "and" followed by the date of publication, e.g. Elugbe and Ajayi (1978); however, when the names appear inside parenthesis, use the ampersand "&" to join them, including the year of publication, e.g. (Edet & Killam, 2001).
- As much as possible, the use of the terms "Idem", "Op. cit.", "Loc. cit." and "Ibid" are to be avoided in textual referencing. Where reference is to be made to a material co-authored or co-edited by more than two scholars, the first name should be followed by "et al." to represent others.
- In most cases, footnotes or endnotes should be used to include other information which may be contextually relevant but digressional to the discourse.

Footnotes or endnotes are marked in each chapter of the thesis with the use of superscripts numbered consecutively starting from [1] or [a]. In the case of Medicine and the Sciences, footnotes or endnotes should be marked at the end of each chapter with the use of superscript in alphabets or Arabic numbers, consecutively and in italics. The superscript is a raised or superior numeral, symbol or alphabet ([1, 2, 3] etc, or [a, b, c] etc).

In citing endnotes, only the name of author, year of publication, title and the specific page reference should be listed. Commentaries, if any, should be made before the citation. The citation should have a full stop only at the end.

- Example: Adadevoh, K. 1968. *Dynamics*, 415.

BASIC INFORMATION ON CITATION LISTING

- All references made to books, journals, and other printed and electronic matters should be listed at the end of the thesis or dissertation under the heading REFERENCES or WORKS CITED.
- All references should be listed alphabetically, according to the surnames of the authors of the works being cited. In the case of Medicine and the Sciences, full references may be made in the form of Endnotes, using consecutive Arabic numerals.
- In listing references, *avoid mixing the surname-initials order with surname-forename(s) order*. Always consider the need to sustain consistency with a particular form, from beginning to end.
- Do not use the parenthesis format to separate the year of publication of any reference; instead, use only the full-stop to distinguish the year from name of the author or the title of the publication.
- In the case of magazines and newspapers, the year of publication (including day and month, in most cases) comes after the title of the periodical in order to retain the dating as one compact unit. In making reference for patents, information should be provided on the "year of release" (which comes immediately after the

name of the patent owner) and the "year of registration" (which comes immediately after the registration number).

- References by the same author should be listed *chronologically*, according to the year of publication. After the first reference and where the second reference for the same author is about to be presented, note that *the name of the same author is only re-presented with ten continuous hyphens* [——————] *followed by a full-stop* (*or a comma plus the name of a co-author if the reference is jointly written*).
- Where works are published in a single year by the same author(s), such references should be listed *alphabetically, according to the first letters of the first main words of the main titles, excepting articles like "A", "An", and "The"*.
- A work with multiple authorships should be cited with the names of not more than five authors in surname-initials order; where there are more than five authors, the fifth name should be followed by "et. al." to represent others. The use of the ampersand - *&* - is advised when listing the names of authors.
- In organizing the list of references, attention should be paid to the paragraphing style: the first line of a citation, starting with the name of author(s), is usually fully justified whereas the second and succeeding lines are indented with one tab spacing to the right of the page.
- All page numbers (Roman and Arabic), however many the digits, should be listed completely.
- Use the standard abbreviations for the months of the year (e.g. in preparing references for magazines, newspapers and other related sources), except *May*, *June* and *July*, which should not be abbreviated.
- Titles of essays and books for reference should be written in lower case after the first word; however all proper nouns including names of places and persons must be capitalized at all times.

GUIDE FOR UIMS

Please note the order of presentation in the standard requirements of a typical reference. Unless otherwise indicated, each part of a reference is marked with a full stop.

Book

Name(s) of Author(s): Surname first, followed by initials of other names.
Year of publication.
(If author is editor, put "Ed." after name, or put "Trans." if same author is translator).
Complete title of the book (in italics)
Editor, translator, or compiler, if any (name in initial-surname order).
Series name, if any, and volume number in the series.
Edition, if not the original.
Number of volumes.
City where published: Name of Publisher.
Chapter or full page numbers (of particular article), if book is edited.

A Work in an Anthology

Name(s) of Author(s): Surname first, followed by initials of other names.
Year of Publication
Title of article (without quotation)
Title of Anthology
Insert "Ed." before name(s) of editor(s)
Place of publication: Name of Publisher.
Page numbers of article in full.

Article in a Journal

Name(s) of Author(s): Surname first, followed by initials of other names.
Year of Publication
Title of the article (with no quotation marks).
Name of the journal (in italics, and *without* full stop).
Volume (and Number, if there is one), in Arabic numerals; Volume is followed with a *full stop* before Number.
Volume/Number is followed by a *COLON*
Page numbers of the article in full.

Article from Magazine
Name(s) of Author(s): Surname first, followed by initials of other names.
Title of Essay (without quotation marks, except as part of the original title).
Name of magazine
Issue or Volume Number
Date of publication (in month-day-year order), with *COLON*
Page numbers of essay in full.

Citation Samples
Book

Mitchell, T. R. & Larson, J. R., Jr. 1987. *People in organizations: an introduction to organizational behavior*. 3rd ed. New York: McGraw-Hill.

Chapter in Edited Book (a)

Bjork, R. A. 1989. Retrieval inhibition as an adaptive mechanism in human memory. *Varieties of memory and consciousness*. Eds. H. L. Roediger III & F. I. M. Craik. Hillsdale, NJ: Erlbaum. 309-330.

Chapter in Edited Book (b)

Ndebele, N. 1998. Memory, metaphor, and the triumph of narrative. *Negotiating the past:the making of memory in South Africa*. Eds. S. Nuttall & C. Coetzee. Oxford: Oxford UP. Rpt. 2002. Chapter 1: 19-28.

A Work in an Anthology

Rubenstein, A. 1986. Children with AIDS and the public risk. *AIDS: facts and issues*. Ed. Victor Gong & Norman Rudnick. New Brunswick: Rutgers UP. 99-103.

Articles from Journals

Mellers, B. A. 2000. Choice and the relative pleasure of consequences. *Psychological Bulletin* 126.3: 910-924.

Badejo, S. O. 1988. Effect of flake geometry on properties

of cement-bonded particleboard from mixed tropical hardwoods. *Wood Science and Technology* 22: 357-370.

Bibles, E. J. and Chen, F. 1968. Sugars and other wood extractives: effect on setting of southern pine mixture. *Forest Products Journal* 18.(9) 28-34.

Article from Magazine

Kandel, E. R. and Squire, L. R. Neuroscience: breaking down scientific barriers to the study of brain and mind. *Science* 290. Nov. 10, 2000: 1113-1120.

Article from Newspaper (where no author is given, begin reference with title)

New drug appears to sharply cut risk of death from heart failure. *The Washington Post*. July 15, 1993: A12.

Encyclopedia Article

Bergmann, P. G. 1993. Relativity. *The new encyclopaedia britannica*. Chicago: Encyclopaedia Britannica. 501-508.

Court Cases

Lessard v. Schmidt, 349 F. Supp. 1078. E.D. Wis. 1972.

Patent

Fawole, I., Afolabi, N.O. & B. A. Ogunbodede. 1986. Description of cowpea cultivar: IFH-101. NGVU-00-22, 2000.

Unpublished Theses, Dissertations, Projects and Essays

Alaba, O.B. 2003. Balance of payment adjustment mechanisms in Nigeria. Thesis. Economics, Social Sciences. University of Ibadan. xiv +183.

Adejobi, A. R. 1994. Stratigraphy and hydrocarbon potential of the Opuama channel complex, western Niger Delta. Diss. Geology, Science. University of Ibadan. x + 66.

Olugbenga, B.O. 2002. Animism in early Israelite religion with particular reference to the Pentateuch. Diss. Religious Studies, Arts. University of Ibadan. vi + 101.

Soyinka, M. 1984. The vision of William Faulkner's writing. Project. English, Arts. University of Ibadan. ix + 56.

Other Sources

Please note that all unpublished materials, personal communications, unpublished interviews, and e-mail references should be cited as footnotes/endnotes, and should NOT appear in the References or Works Cited section.

ELECTRONIC DATABASES AND INTERNET RESOURCES

Generally speaking, articles in electronic form are cited in much the same way that articles in printed sources are cited, with a few exceptions:

- In addition to the standard author, date, article title, source title, source volume number, and page number information, you must also cite the name of the database provider (e.g., Academic Universe, Expanded Academic), and/or the database title (e.g., ABI/Inform, ERIC, WorldCat), and the retrieval date (e.g., "Retrieved July 27, 2001, from Academic Universe database" or "Retrieved July 27, 2001, from http://www.miscellane-ous.com"). Because the contents of some online databases change over time, this date provides additional documentation that a research article was available electronically at a specified point in time.
- When quoting text from an online article, cite a specific paragraph number rather than a page number. For example, a quotation from paragraph 23 of a full-text article would be cited as (par. 23) at the end of the quotation.
- It is advised that researchers depend on or retrieve information from search engines with academic concerns; university directories, certified database, and

academic/refereed journals are preferred.

- Be sure you have the complete document information at the time you download or print a full-text article! Simply printing off a full-text article may NOT provide all of the documentation that you need to write a complete, accurate citation.

Citation Format and Samples for UIMS (Electronic)

Author's Last Name, Initial(s)

Date of Document (if different from date accessed)
Title of document/article

Title of Journal(in italics), or complete work (if applicable)

Volume and issue; version or file number (if applicable)
Edition or revision (if applicable)

Page numbers in the print version (where available)

Number of [paragraphs] in the online version.

Retrieval Date

Source [Database title or Internet site].

One Author

Frederickson, B. L. Mar. 7, 2000. Cultivating positive emotions to optimise health and well-being. *Prevention and Treatment 3*. Article 0001a. Retrieved Nov. 20, 2000, from http://journals.apa.org/prevention/volume3/pre0030001a.html.

Three to Five Authors in Scholarly Journal

Borman, W.C., Hanson, M. A., Oppler, S. H., Pulakos, E. D., & White, L. A. 1993. Role of early supervisory experience in supervisor performance. *Journal of Applied Psychology* 78. 443-449. Retrieved Oct. 23, 2000, from PsycARTICLES database.

Ejournal Article from the Internet

VandenBos, G., Knapp, S., & Doe, J. 2001. Role of reference elements in the selection of resources by psychology undergraduates. *Journal of Bibliographic Research* 5. 117-123. Retrieved Oct. 13, 2001, from http://jbr.org/articles.-html.

Daily Newspaper Article

Hilts, P. J. Feb. 16, 1999. In forecasting their emotions, most people flunk out. *New York Times*. Retrieved Nov. 21, 2000, from http://www.nytimes.com.

Organization/Government/Personal Web Page

U.S. General Accounting Office. Feb., 1997. *Telemedicine: federal strategy is needed to guide investments.* Publication No. GAO/NSAID/HEHS-97-67. Retrieved Sept. 15, 2000, from http://www.access.gpo.gov/su docs/aces/aces160.-shtml?/gao/index.html.

Other Important Points on UIMS (Electronic)

References can also be made of other secondary and multi/media sources like radio/television interviews, video/audio documentaries (Video Home System, Digital Audio Tape), microfilms, and email discussion group/chat. Information gathered from email or group discussions are to be used, advisedly, as footnotes.

Information retrieval should be concentrated on search engines with academic concerns; university directories, certified database, and academic/refereed journals are preferred.

POINTS TO NOTE IN PRESENTATION

Word Processing and Typescript

All textual presentations should be done using Times New Roman, Point 12, except in cases where *special characters* and fonts are required and appropriate. All titles - headings or sub-headings – should not be more than Roman, Point 15.

Titles and Part Numbers
Use Arabic numbers for part numbers (if you have them—Part 1, Part 2, etc.) and for chapter numbers. Type the part titles and chapter titles on separate lines.

Quotations and Paragraphing
All in-text quotations should be in single line spacing. The main body of presentation (narrative, analysis, original argumentation) should be in 1.5 line spacing. Every quotation should be marked by a reference, either by the superscript (in the case of footnote/endnote) or by direct page reference.

Quotations should be made word for word. Always check materials for quotation and proofread carefully before copying. When a part or parts of a quotation are left out, this should be indicated with the use of the ellipsis, i.e. three symbolic periods (…) especially in order to shorten a citation to manageable or logical size.

Indent all quotations that extend more than one paragraph, or that are longer than four full lines of a thesis page. The material is set off from the preceding text and formatted with single spacing *without* inverted commas at the beginning and at the end. Leave an extra blank line before and after the indented quote.

Indent paragraphs with tabs, not spaces. In other words, indented quotes should be formalised with specific, regulated and consistent order. The typical indented quote must be placed within equidistant margins to the centre of the page. For poetry quotes, present the lines or whole stanza as they appear in the original text (but in single line spacing).

There are two acceptable forms of paragraphing: the indented, and the block. Candidates should stick to one of these types of paragraphs and remain consistent throughout the presentation.

Fair and responsible quotation of other scholars' works
The repetitive and copious use of quotations from a particular material or from a set of works by the same author should be seriously discouraged. When a researcher depends on only one or two materials in the writing of a section, a chapter or

his or her presentation in its entirety, or when the main ideas of other scholars are copiously used, either by direct quote, summary or by paraphrasing, such a presentation shall be considered defective, and lacking relative originality.

In more glaring or brazen cases of extensive appropriation of other scholars' works, such presentations could be accused of inadvertent plagiarism.

Notes

Always indicate notes by a superscript number in the text. Place all notes at the end of each chapter. Your word-processing programme should be able to number notes automatically, so that if you need to add a note later, subsequent notes will be automatically re-numbered. Number notes consecutively in each chapter of your thesis.

An acknowledgment or source citation of an article can include a citation of where an oral version was given earlier as well as where material was previously published.

Illustrations, figures, drawings and photographs

All sourced figures, drawings, photographs and maps must be acknowledged appropriately. If self-created or taken by author, such illustrations or photographs should be marked as "Original" followed by date, after the main information. Always number your figures and illustrations by chapter (i.e., 1.1, 1.2, 2.1, 2.2). Also, number tables by chapter (Table 1.1, 1.2, 2.1, 2.2, etc.). Each table should have a "call-out" in the text. Illustrations, tables, drawings, etc., should be on separate pages, with their location clearly marked in the text.

Lists of illustrations and figures; caption copy

Where there are many illustrations in a thesis, an additional page, following the contents page, should be created to provide a list of illustrations, figures, plates, etc (plus the full captions that will accompany them). The list should be in the order in which they are to appear. Captions for images that you do not own should include the credit line.

Spellings and punctuations
British spellings and punctuations are preferred. As much as possible, the overlapping use of Americanisms especially with standard British spellings and punctuations is not allowed.

Special characters
In the case that a presentation has copious special characters (mathematical symbols and equations) or accents (e.g. diacritics in some African language-texts), these should be marked properly and consistently.

Abbreviations
A list of main abbreviations (with full meanings) should appear at the beginning of the thesis, before the contents page.

(*Note that no statistical details, no chemical or mathematical equations, no philosophical musings, no groundbreaking discoveries, and no qualitative narratives will save a thesis without proper referencing!*)

15

ETHICS IN RESEARCH

Obono, O. M.; Ajuwon, A. J.; Arowojolu, A. O.; Ogundipe, G.A.T. ; Yakubu, J. A. & Falusi, A. G.

There is no clear consensus on a complete set of ethical rules to be followed when conducting research involving human subjects – although there are some generally agreed professional guidelines (Marshall, 1994: 157).

INTRODUCTION

The term "ethics" is derived from a Greek word (*ethika*) meaning "character" or "custom". It deals with customary ways of acting and universal and relative judgments as to the rightness or wrongness of human conduct; hence, its association with moral philosophy. As a branch of philosophy, ethics embodies the analysis, evaluation, and development of "normative moral criteria for dealing with moral problems" (Gewirth, 1978: 976). It assigns significance to norms, values, and principles of propriety in the regulation of human affairs. In this sense, ethics constitutes a theory of moral valuation and evaluation and may, accordingly, be defined as the study of morality and its effects on human conduct.

To the extent that it refers to a code of morality, or system of moral principles that governs the appropriate conduct of a group and that of its members, ethics is concerned primarily with things as they ought to be, or the normative. In investigating human conduct, "it is concerned with questions such as

- When is an act right?
- When is an act wrong?, and
- What is the nature, or determining standard, of good and bad?

In asking these questions, ethical theorists have proposed differing accounts of the nature of ethical knowledge, the measure of it, the source of it, the means of knowing it, and how it ought to be applied (*Microsoft Encarta 2004*).

Thus, ethics is the high-minded study of normative conduct, which distinguishes it from science, the study of things as they actually are, or the empirical. When the normative and empirical categories are brought together in research, as might be expected, practical and epistemological problems emerge. Questions are raised as to the need for the combination.

- Is that kind of unity desirable?
- Is it even possible at all?
- Is the very idea of ethics in research not a contradiction in terms?
- Will a focus on ethical issues not deflect attention from the pure scientific pursuit of empirical knowledge about natural, physical, medical and social phenomena?
- Will ethics advance the purpose of research or help to frustrate it?

These are difficult questions. Intellectual disciplines are, by their nature, products of cultural evolution. They embody ideas, ideals and orientations, and develop a sense of propriety through conventional practice and historical consensus. For this reason, it is difficult to proffer standard ethical guidelines that would be endorsed by every discipline. Harmonizing ethics across disciplines is not easy. There are many grey areas that are subject to ideological interpretation (Plattner 2002: 22). A single yardstick or criterion cannot be used to determine ethical process within the same discipline, much less across several disciplines.

New ethical issues are emerging. In an era when policy-relevance and outcome-orientation are extolled as virtues of research and criteria for judging its merit, pressures ranging anywhere from personal, professional to national interest could undermine basic ethical requirements in human subject research. As travel and communication become easier and more frequent, for example, anthropology has found itself embroiled in a moral debate as to the propriety of researcher-respondent intimacy in the field.

Such ethical quandaries (not by any means limited to anthropology) have enlarged, not simplified, the scope of ethical questions that can now be entertained in the social sciences and clinical research. The issues have become more diversified and pertinent because there are more *voices* out there. The field is more nuanced. How should contemporary social research deal with the proposition that, while positivist conventions had promoted scholarly detachment as sound ethical behaviour in the field, a certain degree of such detachment in the face of, say, grave humanitarian crises might in fact be immoral?

In relation to this, the Statement of Ethical Practice of the British Sociological Association (BSA) notes that "Sociologists have a responsibility to ensure that the physical, social and psychological wellbeing of research participants is not adversely affected by the research"; but, "In some cases, where the public interest dictates otherwise and particularly where power is being abused, obligations of trust and protection may weigh less heavily" (BSA, 2003). Is it ethical for a clinical medical researcher conducting research into malaria to do nothing about her discovery of tumors in some children? Should she ignore this discovery and carry on with her specific research objectives, or is it ethically incumbent upon her to refer the child to a competent hospital?

The standards by which ethical conduct in given situations can be determined often vary with the context. Different societies have different measures of attributing ethical status to conduct. The discussion of ethics in research naturally produces discursive tensions, some of which are quite discernable in this chapter. Although we make a broad distinction between clinical and social research, this classification is neither exhaustive nor mutually exclusive. The division is adopted more for conceptual convenience than with any prior epistemological commitments or suppositions in mind.

The next section examines the emergence of ethics in research against a history of serious atrocities in science. They are examined here, as a guide to understanding why ethical considerations are matters of supreme importance in research, whether such research is carried out in the clinical, medical, social, engineering, veterinary, or physical sciences. The key principle is that all disciplines are, in the final analysis, homocentric; they all have equal commitment to enhancing the welfare of people on earth.

ANTECEDENTS TO ETHICAL CONCERN IN RESEARCH

Research ethics specifically deal with the application of moral rules and professional codes of conduct to the collection, collation, analysis, reporting, and dissemination of information about research subjects, whether individually or as a group, especially as regards active acceptance of subjects' right to privacy, confidentiality, and informed consent. These requirements have developed in recognition of the close connections between research and clinical practice, on the one hand, and outcome-oriented research and policy interventions, on the other. In the process, a few persons are from time to time exposed to risks on behalf of the majority, as a result of their participation in one research activity or the other.

The research risks that such subjects face are currently growing in proportion to the number of research activities and the social, demographic, technological, environmental, political, economic, and health problems facing the world. In recognition of this fact, researchers worldwide have adopted high ethical standards as an essential feature of good research. A recent review of the subject declares that:

> It is now widely accepted that any type of study involving humans must be carefully designed and monitored to protect the physical and psychological well-being of the participants. In addition to obtaining informed consent from each participant…scientists are required to monitor study participants closely, and have strict procedures for reporting any adverse experiences. Also, additional safeguards are needed to

> protect vulnerable populations, such as children, prisoners, and people with limited education or mental capacity (Devlin, 2001: 5).

This is the intellectual backdrop as well as the moral imperative of the present chapter. Interest in the subject of ethical issues in human subject research has without doubt gone beyond the subjective sensibilities of individuals. Ethics now assumes a much more central and definitive position in the research process. Reconstituted into the leading criterion for determining the adequacy of that process, it is a primary consideration in modern studies. This occurs against a history of atrocities in science.

The last 100 years of human subject research have been characterized by serious human abuse, which has led to the present emphasis on ethical standards in scientific investigations that involve human participants, or that has direct or indirect implications for human well-being. Human history is filled with numerous stories illustrating human cruelty as well as strong positions on respecting others in the research environment. The impetus to gain new knowledge frequently led to the testing of new chemicals, drugs and treatment modalities on human beings. Falusi (2004) lists a number of such abuses in the history of medical research, the most prominent and infamous of which have included the anti-Semitic Nazi medical experiments of 1930-1945. These were extensive experiments conducted on mentally retarded and mentally ill Jewish prisoners to test their endurance levels with electric shocks, severe hypothermia, exposure to poisons, infections with diseases and irradiation to induce sterility.

Although not listed by Falusi (2004), the Mississippi Appendectomies rank among the most disturbing historical examples of what happens when scientific procedures are adopted in aid of a racist eugenic agenda. From the 1920s right up to the 1970s in the United States, poor people (mostly Black women) were routinely sterilized without their knowledge or consent. Poor African-American women were involuntarily made to have hysterectomies (the surgical removal of one or more of the female reproductive organs), as a means of curbing the growth of the "unfit population" or what American eugenicists described as the "less desirable classes". From 1907 to 1941, more than 36,000 people were forcibly sterilized, mostly in California, Virginia, and Indiana, primarily for "feeblemindedness" or for having been born into large welfare families. Dorothy Roberts reports in "Killing the Black Body" that, during the 1970s, sterilization became the most rapidly growing form of birth control in the United States, rising from 200,000 cases in 1970 to over 700,000 in 1980. According to her, "It was a common belief among Blacks in the South that Black women were routinely sterilized without their informed consent and for no valid medical reason. Teaching hospitals performed unnecessary hysterectomies on poor Black women as practice for their medical residents. This sort of abuse was so widespread in the South that these operations came to be known as 'Mississippi appendectomies'" (*Socialist Action*, March 2001).

In 1975, a hysterectomy cost $800 compared to a tubal ligation, which was much less expensive. This gave surgeons, who were reimbursed by Medicaid, financial incentive to perform the more extensive (and dangerous) operation. Hysterectomies are 20 times more likely to kill the patient than tubal ligation. According to *Socialist Action*:

> Fannie Lou Hamer, the leader of the Mississippi Freedom Democratic Party, informed a Washington, D.C., audience in 1965 that 60 percent of the Black women in Sunflower County, Mississippi, were subjected to postpartum sterilizations at Sunflower City Hospital without their permission. Hamer had suffered this violation herself when she went to the hospital for the removal of a small uterine tumor in 1961. The doctor took the liberty of performing a complete hysterectomy without her knowledge or consent. This practice of sterilizing Southern Black women through trickery or deceit was confirmed by a number of physicians who examined these women after the procedure was performed (*Socialist Action,* March 2001).

The April 1872 edition of *the Boston Globe* ran a front-page story on complaints by a group of medical students that Boston City Hospital was performing excessive and medically unnecessary hysterectomies on Black patients. The charges included: surgeries were performed for "training purposes"; radical and dangerous procedures were used when alternatives were available; medical records did not reflect what had really been done to patients; patients were pressured into signing consent forms without adequate explanation; and doctors treated patients callously, adding to the women's anguish. These were gross violations of ethical standards. In the opinion of New York eugenic urologist William Robinson, these unethical procedures are justified on grounds that:

> It is the acme of stupidity to talk in such cases of individual liberty, of the rights of the individual. Such individuals have no rights. They have no right in the first instance to be born, but, having been born, they have no right to propagate their kind (Pence 1990)

Also in the United States, the Tuskegee Syphilis experiments of 1932 -1973 involved 600 poor African-American men with syphilis, two-thirds of whom were already at an advanced stage of the disease. These men received free medical attention but were not treated for syphilis. They were promised free meals and fifty dollars ($50) burial stipend, but, despite the discovery of Penicillin in 1943, they received no treatment until a media exposé in 1972. The project was halted; the Department of Human Education and Welfare (DHEW) was indicted; a ten million dollar settlement was reached in 1974; and an Advisory Committee on Human Research Ethics (ACHRE) was set up in 1977 by President Clinton, who also tendered a public apology to the victims and their families (Falusi 2004).

The Timothy Leary and Richard Alpert experiments were conducted from 1960 to 1963. These researchers tested the effect of hallucinogenic drugs such as LSD on human personality using friends, associates and students. They were finally stopped in 1963. The ethical violations in these cases were of disturbing proportions. Even the aged and elderly were not left out of these abuses. Ordinary civility towards senior citizens was not upheld.

At the Sloan Kettering Cancer Centre, the Jews carried out an experiment to study the effect of foreign tissue on certain body reactions. The set of experiments was termed "harm-less skin test". In these experiments live cancerous cells were injected under the skin of old, disabled patients with compromised immune systems. As Alex Capron observed in 1989, despite the Hippocratic Oath sworn to by doctors, "the darkest moments in medical annals have involved abuses of human subjects".

It is necessary to point out that ethical abuse in the course of scientific research is by no means limited to Western countries like Germany and the United States. Indeed, the violations are more frequent and worse in their impacts in Africa. One notable example is the unethical research on children in Kano (Nigeria) in April 1996 by a pharmaceutical company. The process led to the death of a 10 year old girl after receiving a 3-day free treatment from a humanitarian charity group, Doctors without Borders. The antibiotic (Trovan) used was an unapproved drug in the United States but, since the company could not find enough patients in the United States, it brought the drug to Kano upon reports that the death toll from meningitis was on the rise.

In the Kano experiment, the pharmaceutical company had no signed consent forms. The patients did not know that they were participants in an experiment. They only knew that they were sick and receiving medical treatment. This is an example of corporate drug experiments conducted by private interests in Africa, with little independent oversight, while humans are used as guinea pigs, and pledges of quality medical care sometimes fatally hollow. In a 2000 report titled "The Body Hunters Exporting Human Experiments", *The Washington Post* found that, given a situation where there was abundance of subjects and minimal oversight abroad, big American drug companies test their products overseas in order to get them to the market faster. Noting the vulnerability of African research population to manipulation and coercion, the report drew attention to the special need to protect human subjects in research.

The examples so far cited are drawn from medicine and clinical research, but ethical abuse extends beyond medicine and clinical drug trials and research. It abounds also in the social sciences. For the purpose of this chapter, only one historical example of ethical violations in the social sciences will be discussed, and that is Project Camelot, which is one of the best known examples of abuse in the social research context. No other instance of social science ethical malpractice adversely affected the integrity of American social science scholarship as did Project Camelot.

Initiated in 1964, the project was an expensive (six million dollar) multidisciplinary research study of insurgency in some 30 countries, which originally did not include Chile – the country where the crisis broke. Sponsored by the United States Army and the Department of Defence, Camelot was abandoned after "a series of rapid events that began in Chile, a country not even mentioned in the proposed list" (Reissman, 1968: 117). The gravamen in that scandal was the fact that the American social scientists involved in the proposed project withheld information as to the true sources of its funding from the Chilean media and their Chilean academic counterparts.

Trouble broke out when this became public. Tempers flared in Latin America. American scholarship went instantly on a critical ethical trial, which it lost. What followed was the noisiest ethical imbroglio in the professional history of the social sciences. As one reviewer noted, "No instance of scholarly activity [had] ever affected hemispheric relations so profoundly as the exposure in 1965 of the notorious Project Camelot, a research study of counterinsurgency in Chile which proved to have the backing of the United States Army" (Tomasck 1969: 116). For Kalman Silvert,

> The immediate cause of the present contretemps is the attempt of the Special Operations Research Office of American University to launch a large-scale socio-political study of internal warfare in Latin America with funds provided by the Department of the Army. The extremely noisy debacle which ensued almost immediately cannot be explained in the narrow terms of a few bungling individuals or even of misguided policy; the ground for today's disgrace was well prepared by the ethical incomprehension, cavalier attitudes, and tolerance of ignorance manifested by American universities and scholars for many years. (Silvert 1965: 216)

As Reissman noted at the time, "The extremes of Chilean reaction were directly proportional to the linguistic and historical ignorance of American scientists in Latin American studies, as well as their abysmal lack of scientific manners" (1968: 1118).

Camelot occurred at a time of international civil struggles, which created a critically conscious global citizenry, aware of its rights and prepared to defend them. America was at war with itself over the African-American Civil Rights Movement and the propriety of Vietnam. The media was embroiled in nationalist and ideological campaigns and was very unsparing of imperialistic tendencies. Post-War Europe was still restive and in the grip of anti-Establishmentarian existentialist thought – à la Martin Heidegger (1889 – 1976) and Jean- Paul Sartre (1905 – 1980). Within Latin America, dependency theory was ideologically suspicious of modernization theory, which it castigated as the morally bankrupt intellectual creation of Western political economy.

In one sense, Camelot could not have come at a worse time or place than in Chile in the 60s; in another, it could not have come at a better. Although the project was tragically misguided and ill-timed, the ensuing scandal gave rise to greater ethical sensitivity in the social sciences. The old arrogant attitude towards research subjects is no longer tenable. Formal codes of inquiry are being developed and adopted everywhere, although, in Nigeria, much still needs to be done. Many national professional bodies are not strong enough to preside over the ethical conduct of their members in and outside the field. Researchers who adhere to these ethical requirements usually borrow them from the provisions of the ethical codes of foreign or international associations like the British Sociological Association (BSA), the North American Sociological Association (NASA), or the International Sociological Association (ISA). This invariably means that there are few internal institutional guarantees against ethical misconduct among Nigerian researchers and foreign researchers working in the Nigerian field.

ETHICAL CODES OF CONDUCT AND INSTRUMENTS

A series of codes of conduct came into existence to correct anomalies in the ethical conduct of research. These include The Nuremberg Code (1947), the Belmont Report, the CIOMS International Ethical Guidelines for Biomedical Research Involving Human Subjects, the 45CFR 46, the World Medical Association Helsinki Declaration (1964; 1975; 1983; 1989; 1996; 2000), WHO Operational Guidelines for Ethics Committees that Review Biomedical Research.

The Nuremberg Code was an outcome of the war crimes tribunal at Nuremberg. It laid down 10 standards to which physicians must conform when conducting experiments on human subjects. This judgement established a new standard of ethical medical behaviour for the post-World War II human rights era. It declared that "The voluntary consent of the human subject is absolutely essential". Other provisions of the Nuremberg Code include: experiments must be strictly beneficial to individuals or their communities, or the society in general; animal experiments previously conducted and the natural history of the disease must be clearly identified before human subject research is commenced; there must be no unnecessary physical, mental harm, injury or death to participants; a reasonable risk/maximum benefit ratio must be maintained; scientists must be competent and professional; participation must be voluntary while avenues must be available for withdrawal from study; and the scientist in charge of an experiment must be prepared to terminate it prematurely, if he or she had "probable cause to believe, in the exercise of the good faith, superior skill and careful judgment required of him, that a continuation of the experiment is likely to result in injury, disability, or death to the experiment subject" (*BMJ* 1996).

In June 1964, the 18th General Assembly of the World Medical Association (WMA) adopted the "Ethical Principles for Medical Research Involving Human Subjects" at Helsinki (Finland). It has been amended 5 times since its adoption. Although the Helsinki Declaration recognizes that "Medical progress is based on research which ultimately must rest in part on experimentation involving human subjects", it upholds the principle that "In medical research on human subjects, considerations related to the well-being of the human subject should take precedence over the interests of science and society". Its 18 Basic Principles for All Medical Research and the 5 Additional Principles for Medical Research Combined with Medical Care can be summarized around the principles of respect for persons, beneficence, and justice.

The International Mandate was developed as a set of rules and guidelines to regulate human subject research. It (*The Mandate*) recognizes human subject research as comprising scientific procedures that set out to test and develop new treatment therapies to combat diseases, as well as to study and formulate public health safety issues for the social well-being of humans. *The International Mandate* incorporated provisions from previous Codes of Conduct, and has adopted the four cardinal principles of ethical guidance of Respect for Persons, Beneficence, Non-Malfeasance and Justice. A Code of Conduct was signed into law in July 1974 as the National Research Act. The National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research was created.

The Belmont Report of Ethical Principles and Guidelines was published in 1978. It stresses the autonomy of participants and persons with diminished capacity e.g. foetuses, children, pregnant women, prisoners and others who must have their rights respected. Project benefit to participants must be maximized with the risk/benefit ratio adequately assessed. There must be no harm to the participants. Research must be responsive to local needs. Justice must be equitable in the selection of participants. Selection must not be based on convenience to researchers or on poverty status of participants. The Community must be the beneficiary of the research carried out in their locality.

The Federal Oversight by the Office of Human Research Protection (OHRP) 45 CFR 469 section applies to all research regulated by the Federal Agency of the United States. Since Nigerians and Americans collaborate in research, the former might invariably be guided by this code. The 45 CFR 46 defines the functions and operations of institutions, institutional review bodies and investigators. It establishes criteria for Exempt status. It also defines categories of protocols for Expedited Reviews. It classifies vulnerable populations for additional and more extensive reviews.

ETHICAL ISSUES IN CLINICAL RESEARCH

All biomedical and behavioural research involving human participants must be guided by three universal ethical principles – respect for persons, beneficence and justice. These principles were developed to safeguard the rights and dignity of persons who participate in research. They evolved in response to atrocities committed against research participants in the past and are contained in the ethical codes of many countries, such as the *Belmont Report* (articulated by the U.S. National Commission for the Protection of Human Subjects of Biomedical and Behavioural Research in 1976). In general, human subject research deals with scientific investigations, which are conducted according to laid down ethical guidelines and aimed at improving the quality of human life. Along these lines, "Medical research involving human subjects has the primary purpose of improving prophylactic, diagnostic and therapeutic procedures and understanding of the etiology and pathogenesis of disease" (Falusi 2003:1). Human subject research involves the use of human tissue, blood, urine, organs, other human data (including data of dead patients), x-rays, and responses from people for purposes of a social or clinical research.

Owing to serious human abuse such as those identified in the preceding section, there is a contemporary insistence on the ethical standards in the conduct of scientific research. This concern extends to the organization and benefits of research. In their article "What Makes Clinical Research Ethical?" Emanuel, Wendler and Grady (2000) examine basic philosophies underlying major codes, declarations, and other documents relevant to human subject research. They outline seven ethical requirements in clinical research: the value of the research; the scientific validity of the research; the need for fair subject selection; the achievement of favourable risk-benefit ratio; the need for independent review by unaffiliated individuals to approve, modify and terminate the research; the need to emphasize the value of voluntary informed consent; and the need to maintain respect for participants in the research: this includes respect for their privacy and well-being at all times. These seven principles are decomposable into the basic ideas of respect for persons, beneficence, and justice, which are discussed below.

Respect for Persons

According to the *Belmont Report*, respect should proceed from two convictions. First, it should emanate from a view of the subject as an autonomous being, one that has self-rule and self-determination. Second, it should emanate from a view of the subject as one that has that autonomy diminished by old age, physical impairment, lack of education, incarceration, debilitating financial and other social circumstances and mental illness. Persons who fall within these and comparable categories deserve additional precautions in research. They must be protected from harm and risks that could attend their participation in the research. They must also be reassured of their right to voluntarily decide whether or not to take part in the research and to withdraw from it without suffering reprisals.

One of the ways the principle of respect for persons is put into practice is in the execution of informed consent. Informed consent involves giving a prospective research participant adequate information concerning a study. The researcher must provide the participant with ample opportunity to consider all options, respond to his or her questions, ensure that he or she understands this information and obtain his or her agreement to participate in the research without undue influence or coercion. Freely given informed consent should be obtained from each volunteer before the research procedure begins. Informed consent that is written through the use of consent forms is the preferred option. Consent forms are necessary because they document that the consent-giving process actually took place. They provide evidence that a participant gave authorization to be involved in the research.

There are, however, practical difficulties with the use of written consent forms in social and clinical research. These occur, for instance, "in most ethnographic contexts [where] it is not only inappropriate but also potentially harmful in countries and institutions where signing documents is threatening" (Hunn and Rhodes 2002: 22). Also, who gives consent, and at what level? At what level are the institutional approval of research and a village chief's consent to it valid? How is consent to be obtained at the various levels at which the need for it appears? In an on-going study of socio-economic factors influencing the incidence of malaria among secondary school children, are principals', class teachers' and students' consent to the investigation adequate? Should parental consent also be sought?

In other contexts, the use of consent forms in Nigeria poses two challenges. First, there is general scepticism about documentation owing to the fear that signed documents may be used for purposes such as taxation. Second, concern about documentation is usually elevated in behavioural research on sexual behaviour in which participants are required to answer sensitive questions on extra-marital relationships, covert contraception, condom use, sexual networking, and contact with a sex worker. Married persons may be concerned about the confidentiality of such sensitive information and may, therefore, be reluctant to complete a consent form, provide reliable answers, or even participate in the research. Thus, while the questionnaire may grant anonymity, consent forms make the respondent's identity explicit. These situations undermine the validity and reliability of data on risky sexual practices, but the participant's right to the researcher's respect and protection is greater than these considerations.

Although informed consent is a recurrent requirement in ethical discourse, Emanuel *et al* attribute the tendency to view it as a paramount ethical consideration , or as the most significant measure of ethical compliance, to "the near obsession with autonomy in US bioethics". They argue that informed consent is neither necessary nor sufficient for ethical clinical research, because

> contemporary ethical controversies in clinical research, such as clinical research in developing countries, the use of placebos, phase 1 research, protection for communities, and involvement of children, raise questions not of informed consent, but of the ethics of subject selection, appropriate risk-benefit ratios, and the value of research to society (Emanuel *et al* 2000: 2701)

Beneficence

Beneficence deals with the responsibility of researchers to maximize benefits and minimize harm and risks to persons who participate in the research. The benefits of research refer to value added to the health or welfare of individuals or the society as a whole. Risk refers to the possibility that harm may occur either in the course of the research or as a consequence of it. Although the conduct of research may bring some benefits to research participants and the society as a whole, it may also involve risk. Such risk must be made clear to participants. Since the risk involved in the research may be physical, social or psychological, the principle of beneficence requires investigators to conduct a reasonable assessment of both the potential risks and potential benefits involved in a research before its implementation.

Related to this principle is the need to take steps to reduce the exploitive tendency of modern research. Communities regularly complain that they have participated in one research after another for years with no results to show for it. Researchers appear to be uncaring miners basically out to mine social facts without paying much attention to the devastation that process causes to the physical and moral environment. The situation leads to the suspicion that, under the prevailing moral environment in which researchers operate, they have like their ordinary market counterparts in the economy, acquired that predatory instinct that is so critical to making progress in the world today. The researcher in this regard does at a social research level what other individuals do at the level of oil exploration, diamond production and their numerous consequences. It is imperative that research proposals demonstrate the immediate, intermediate, and ultimate benefits of the proposed investigation to the full understanding and acceptance of both the ethical review boards and the communities and research subjects themselves. This demonstration should contribute to the basis for estimating its relevance and suitability for approval.

The principle of beneficence also requires that investigators be competent enough to conduct the research and to safeguard the welfare of persons who participate in it. According to the *Belmont Report*, "persons are treated in an ethical manner not only by respecting their decisions and protecting them from harm, but also by making efforts to secure their well-being". In this regard, beneficence places responsibility for the physical, mental and social well-being of the subjects directly on the researcher conducting the study. It entails that protecting the human participant and preventing him or her from any harm is more important than the pursuit of new knowledge and "it takes precedence over the personal or professional gain of the researchers" (Devlin 2001: 5). The vacuous appeal to "the interests of science" or "knowledge for knowledge's sake" is therefore out of order. If science is meant to increase the well-being of people, it should not do so by decreasing their well-being. These principles have evolved over time to protect the research subjects as awareness of ethical breaches through research activities became pronounced.

Justice

In principle, participation in research should grant the participant basic rights to the benefits of that research. It is unjust and unethical to withhold such benefits from participants. The *Belmont Report* states that "an injustice occurs when some benefit to which a person is entitled is denied without good reason". Research should be responsive to the needs of the people who participate in it and any product developed from such research must be made available to the participants. The principle of justice also requires fairness in the distribution of both the benefits and risks of research. The burden and benefits of participation in research should be equitably distributed across the community. Research participants should not be selected because of race, ease of access, or their compromised positions. The principle of justice requires inclusion of diverse elements of the population.

Beyond this, it is noteworthy that while justice is central to the assessment of research procedures, how far violations of this principle are actionable depends on subjects' capacity for litigation. The factors that produce injustice in, say, the selection of study participants (such as poverty, imprisonment, or absence of education) may also disenable them from taking legal action.

ETHICAL ISSUES IN SOCIAL RESEARCH

As used in this chapter, social research refers to a diverse corpus of investigation strategies together with the logics and rationales underlying their eclectic selection and use. In this sense, the social research process is used in close conjunction with methodology, which varies across disciplines, and multiple assumptions and paradigms within disciplines. In the social sciences, Weberian *wertfrei* still exerts influence on the modern approach to methodology, and much debate still rages on the question of value neutrality. But, more than any single develop-ment in the last century, the scandal of Project Camelot was what set the stage and context for a close examination of the relationship between social science and practical politics.

The Camelot scandal was a frightening wake-up call to the scientific world. It remains an enduring embarrassment to American social science scholarship, which provided impetus to the development of ethical codes that would guide social scientists in and beyond the research field. The legacy of that scandal remains with the present generation of researchers in that it generated four main areas of ethical concern.

1. The corruption of social science values in a pretended pursuit of scientific truth;
2. The credibility and competence of social scientists engaged in investigations;
3. The need to socialize social scientists to ethical standards; and
4. The need to decolonize contemporary power relationships between Nigerian researchers and their Western collaborators.

These issues run through the commentary in the following sections.

Ethical Tensions in the Social Sciences

Despite relative progress on several fronts, some hard-line positions remain. The predictable position of the modern empiricist – that curious incarnation of the Camelot mentality – is that the objects of science are too critical to be compromised by non-scientific distractions belonging more to metaphysics and ontology than research. Such hardliners insist that science must remain silent on value judgement questions, since scientific analysis can only deal with facts.

As noted earlier, this is a strong positivist position that dates back to Weber who, in his "The Meaning of 'Ethical Neutrality' in Sociology and Economics" (1949), presented a set of propositions that subsequently made it virtually axiomatic to hold that the formal study of Sociology is, and must be, value-neutral, or free from values – *wertfrei*, in the German original. For Weber, scientific analysis of any phenomenon must be objective and non-advocative. Accordingly, Sociology, Economics and, by extension, the rest of the social sciences cannot entertain any "oughtness" in their own analyses.

This view drew the ire of Alvin Gouldner in his "Anti-Minotaur: the Myth of a Value Free Sociology". In it, he argued that the value-free stance of Sociology was, in the first instance, pretentious (Gouldner 1962). Every action is laden with meaning, which is meaningful because it possesses value. In other words, there is no value vacuum in society. This is in spite of the fact that "Generations of students – particularly in the post-war period were led to believe by a considerable number of Foundation-sponsored social scientists that ideology had been done away with altogether and that it had been replaced, for good, by the sound and sober systems of strictly factual social science" (Meszaros 1986: 1-2).

Anti-positivist critique against the Weberian value-neutrality became more intensive in the past two decades under the influence of critical postmodernism. The critique regards value neutrality as erroneous because every single stage of the research process is manifestly value-laden, and should be. The fact-to-value gap is based on a mistaken dualism and misleading fallacy. Feminist scholars challenge "the persistent positivist myth" that science is value free (Haig 1997). Critical theorists regard the distinction between facts and values as a device for disguising the role of conservative values in social research. That is to say, what exist are actually conservative values masquerading as neutral ones. Instead of value neutrality therefore, critical theorists argue for research agenda that are openly ideological (Hammersley 1995).

Value neutrality is also deemed to be dangerous because it was the amoral harbinger of the terrible events that culminated in Nazi anti-Semitism, its demented medical experiments and, finally, its horrific Holocausts. Value neutrality is a perpetually threatening precursor to racial genocide. Hence, "The attempt to produce value-neutral social science is increasingly being abandoned as at best unrealizable, and at worst self-deceptive, and is being replaced by social sciences based on explicit ideologies" (Hesse 1980: 247).

The emerging consensus is that:

> At this point, *at a minimum,* we should be prepared to admit that values do play a significant part in inquiry, to do our best in each case to expose and explicate them…and, finally, to take them into account to whatever extent we can. Such a course is infinitely to be preferred to continuing in the self-delusion that methodology can and does protect one from their unwelcome incursions. (Lincoln and Guba 1985: 186)

Marshall addresses this problem by concluding that "There is no clear consensus on a complete set of ethical rules to be followed when conducting research involving human subjects – although there are some generally agreed professional guidelines" (1994: 157).

In line with this, our view is that the value systems of Nigerian societies need to be taken into account in the formulation of ethical protocols for social or clinical research in Nigeria. How do the communities feel about the ethical assumptions being made by the researcher? What need needs to be added or subtracted from consent forms in order to capture more fully the orthodox Nigerian apprehension in matters related to the handling of human blood, say in sero-prevalence studies? How do we work African expectations of courtesy into ethical protocols without unduly making the investigation impossible or unnecessarily burdensome for the researcher? The specification of peculiar ethical concerns at the individual or community level should form part of the interests of pilot investigations, so that the substantive survey will embody these concerns.

Ethical Consensus in the Social Sciences

The discourse of ethics has, without doubt, changed. The issues have grown more complex. There are emergent trends in that discourse. With the emergence of a critical mass of indigenous social scientists, trained locally and abroad, the neocolonial monopoly on the determination of what needs to be studied has effectively been broken. The relativity of ethics is now more apparent. Totally new questions are being asked, including those concerning the nature of cross-Atlantic institutional "collaborations", the continuing tendency among Northern institutions and researchers to treat "colleagues" from the developing world as consultative adjuncts to projects. This tendency has rightfully been elevated to the level of an ethical problem.

Thus, one of the dominant ethical questions in the Nigerian social sciences today deals with the unequal power relationships between collaborating African and non-African partners in research conducted in Africa, and the cynical division of labour and appropriation of benefits that arise from that basic inequality. The ethical considerations which are implicit in these unequal power relationships range from agenda setting to project execution. These processes violate and undermine the principles of respect for persons (including persons who are research "partners"), beneficence, and justice. A highly critical indigenous opinion is emerging within the social sciences as to the desirability of interrogating field practices that may no doubt constitute ethical violations when this more basic, more fundamental and overarching problem exists. This is the ethical beam in the eye of some Western scholars with research interests in Africa.

Generally, researchers tend to pay more attention to possible ethical difficulties in their research while utilizing qualitative methods than they do while using quantitative techniques. By its nature, qualitative research is often more invasive from many angles. Some qualitative research deals with "the most sensitive, intimate and innermost matters in people's lives, and ethical issues inevitably accompany the collection of such information" (Punch 1998: 280). In quantitative work, on the other hand, respondents can often simply refuse to answer questions that they find too personal, especially if the instrument is self-administered. But, with its reliance on observations, open-ended interviews, and other somewhat stealthy methods, qualitative research can more easily build rapport and lull informants into divulging much more than they might have desired to.

Miles and Huberman (1994: 290-7) discuss thirteen ethical issues, which include worthiness of project, competence boundaries, informed consent, benefits, costs and reciprocity, harm and risk, honesty and trust, privacy, confidentiality and anonymity, intervention and advocacy, research integrity and quality, ownership of data and conclusions, and the use and misuse of results. To this list, Punch (1994) adds deception. Seven key issues emerge from this.

1. Research subjects have the right to withhold cooperation from a study whose benefits are not clear to them. This right is clear-cut in relation to interview surveys but is not always observed in relation to case studies, especially when covert techniques, such as unobtrusive observation, are employed.

2. The privacy of respondents should be protected through the practice of informed consent. This is related to the issue of justice. Subjects should be informed that their behaviour is under close observation. Photographs posed for (implicit consent) are taken on the understanding that the participant will be given a copy of such photographs. The publication of photographs requires more formal forms of consent.

3. Subjects should not be exposed to undue stress, manipulation, personal risk or harm. This is related to the issue of beneficence.

4. The researcher is responsible for preserving the confidentiality of information received, and anonymity of respondents where that is either desired or to be expected. The protection of data in this regard has become crucial and subject to certain legal requirements in some countries.

5. In addition to the conduct of research, ethical guidelines also govern the presentation of results. There are ethical implications concerning how these may be used, because, as Robert Friedrichs observes in his *A Sociology of Sociology* (1970), "knowledge of man is never neutral in its import; it grants power over man as well".

6. The "benefits of research" should be demonstrated as parts of the process of obtaining consent. This should

be worked into the research proposal.

7. African ethics surrounding exit behaviour should be respected because "all ethnography requires researchers to enter the 'worlds' of other people and to respect the ways those people deal with outsiders" (Hunn and Rhodes 2002: 22). The data should be made available to the community in a spirit of collaboration. The researcher is obliged to bring his or her findings to the subjects, as this might lead them to take necessary action towards solving the identified social problem.

Duneier's (1999) emphasis on "respondent validation" is well placed among this list. It requires the researcher to present his or her results and interpretations to the community in which data were collected so as to ascertain whether that interpretation is biased or not. Again, this is virtually imperative where methods like participant observation, in-depth interviews, key-informant interviews, or the collection of life histories were utilized. In the life history technique in particular, there is a high likelihood for the interviewer's own perceptions to affect the story that the life history respondent narrates (Obono, forthcoming) and, for that reason, respondent validation is critical in such instances.

THE ROLE OF IRB/ERB/IRC IN THE PROTECTION OF RESEARCH PARTICIPANTS

Ethical principles are applied in practice through initial and continuing education of research investigators and sponsors, and research proposal review by Ethics Review Committees (ERCs), an example of which is the University of Ibadan/University College Hospital Institutional Review Board (UI/UCH IRB). ERCs and IRBs are institutions to conduct scientific and ethical review of proposed research before its commencement. Their main role is to ensure the safety, dignity, rights and well-being of actual and potential research participants. They provide independent, competent and timely review of both the ethics and science of proposed studies and monitor the implementation of such projects to ensure that they are carried out ethically. But the monitoring of post-field activities, such as plagiarism, is weak. Available technology provide software and on-line avenues for monitoring plagiarism, but these are not being systematically used in Nigerian institutions, with the result that abuse of the publication and dissemination process – even in postgraduate reports – passes undetected, unquestioned, and undeterred.

While the existence of Institutional Review Boards (IRBs) signifies institutional seriousness with ethical questions, there is still a need for communities to function as their own ethical gate keepers. If there is non-compliance with ethical guidelines in the preparation of the protocols, or some changes go unreported to IRBs/IRCs or adverse events in the field not promptly reported to the IRBs/IRCs or the Institution, then exploitation in human subjects research will continue. A good example of non-compliance with ethical guidelines is the Johns Hopkins University (JHU) asthma experiments in which Ellen Roche a 24 year old employee volunteer participant died after inhaling experimental hexamethonium which destroyed her lungs. JHU-IRB and the Institution's research set up were accused of improper conduct of research and therefore its research outfit was suspended for a period of time.

The Office of Human Research Protection (OHRP) visited the Institution and OHRP's actions taken included among others:

- suspension of all Multiple Protection Assurance (MPA) on July 16, 2001;
- suspension of all Federally sponsored research in JHU;
- a demand for all their research protocols used in protecting human subjects including the educational training profile of IRB members, staff and researchers;
- a demand for re-evaluation of all protocols.

The oversight inspection team discovered non-compliance problems of protocols including:

- The Principal Investigator I did not give IRB published toxicity information on the research product.
- The drug was not approved for human use.
- Quality of drug was uncertain.
- PI did not report for the protocol amendment after the adverse event of the previous subject.

- IRB failed to solicit sufficient information for continuing review of project.
- IRB inappropriately used expedited review of protocol.
- IRB minutes of meetings were inadequate.
- IRB work flow was backlogged.
- IRB was understaffed and overworked.
- Some IRB members had conflicts of interest.
- IRB did not approve protocol changes

Informed consent weaknesses detected are:

- Inadequate description of procedures in the protocol;
- Failure to disclose drug status;
- Inadequately disclosed risks.

ESSENTIAL ELEMENTS OF A GOOD PROPOSAL

The research proposal must be submitted with adequate supporting documents which give special attention to the informed consent process, documentation and suitability and feasibility of protocol. Investigators need to include prior scientific reviews if any and the requirement of applicable laws and regulations well considered. The following aspects of the proposal are of paramount importance.

Scientific Design and Conduct of the Study

- The appropriateness of the study design in relation to the objectives of the study, the statistical methodology (including sample size calculation), and the potential for reaching sound conclusions with the smallest number of research participants;
- The justification of predictable risks and inconveniences weighted against the anticipated benefits for the research participants and the concerned communities;
- Criteria for prematurely withdrawing research participants;
- Adequacy of the site, including the supporting staff, available facilities, and emergency procedures;
- The manner in which the results of the research will be reported and published.

Recruitment of Research Participants

- The characteristics of the population from which the research participants will be drawn (including gender, age, literacy, culture, economic status, and ethnicity);
- The means by which full information is to be conveyed to potential research participants or their representatives;
- Inclusion of criteria for research participants;
- Exclusion criteria for research participants.

Care and Protection of Research Participants

- Qualification and experience of Investigators for the proposed study;
- Investigator's plans to withdraw or withhold standard therapies for the purpose of the research, and the justification for such action;
- The medical care to be provided to research participants during and after the course of the research must be stated;
- Adequacy of medical supervision and psycho-social support for the research participants must be emphasized;
- Voluntariness of participation and withdrawal should be clearly stated;
- A description of any plans to make the study product available to the research participants following the research;
- A description of any financial costs to research participants;
- The rewards and compensations for research participants (including money, services and/or gifts);
- The provisions for compensation/treatment in the case of injury/disability/death of research participants attributeable to participation in the research must be clearly stipulated.

Protection of Research Participant Confidentiality

- A description of the persons who will have access to personal data of the research participants, including medical records and biological samples;
- The measures taken to ensure the confidentiality and security of personal information concerning research par-

ticipants.

Informed Consent Process

- A full description of the process for obtaining informed consent, including the identification of those responsible for obtaining consent;
- The adequacy, completeness, and understandability of written and oral information to be given to the research participants, and, when appropriate, their legally acceptable representative(s);
- Clear justification for the intention to include in the research individuals who cannot consent or authorization for the participation of such individuals;
- Assurances that research participants will receive information that becomes available during the course of the research relevant to their participation (including their rights, safety, and well-being);
- The provisions made for receiving and responding to queries and complaints from research participants or their representatives during the course of a research project.

Community Considerations (where applicable)

- The impact and relevance of the research on the local community and on the concerned communities from which the research participants are drawn;
- The steps taken to consult with the concerned communities during the course of designing the research;
- The influence of the community on the consent of individuals;
- Proposed community consultation during the course of the research;
- The extent to which the research contributes to capacity building, such as the enhancement of local health care, research, and the ability to respond to public health needs;
- A description of the availability and affordability of any successful study product to the concerned communities following the research;
- The manner in which the results of the research will be made available to the research participants and the concerned communities;

In handling your proposal for submission, therefore, some legacies for ethical review clearance and approval include that your proposal must have:

- Value
- Scientific validity
- Fair subject selection
- Favourable risks/benefit ratio
- Respect for enrolled human subjects
- Detailed informed consent

ETHICAL ISSUES IN VETERINARY RESEARCH

- Clinical trials – efficacy and toxicity of human and animal drugs
- Food/feed trials - nutritive value and safety of food/ feeds
- Disease effect – aetiology, pathogenesis, clinical signs and pathology of diseases.
- Breeding experiments
    - Cross breeding – different breeds
    - Inter breeding – different species
- Cloning research
- New Surgical procedures
    - the open heart surgery.

These studies are aimed at improvements in human health, animal production and health and new frontiers in technology

What is an animal?

An ethical grouping of animals is presented in the table below.

Cruelty to Animals

The law forbids the injection of poisonous drugs into animals, causing animals to starve and any act which subject experimental animals to undue suffering. The Nigerian Criminal Code and the Penal Code (of Northern Nigeria) defined such acts as cruelty to animals and impose heavy penalties. A researcher using experimental animals to test the potency of new drugs or the nutritive value of new feeds may need veterinary assistance to avoid or ameliorate undue suffering to animals in the course of the study.

Ethical grouping	Type of research	Examples
Experimental animals -kept and fed by research body.	Non-clinical Research	Laboratory & farm animals kept for research
Client-owned animals -brought to veterinary hospitals for treatment.	Clinical Research	Dogs, cats, livestock and zoo animals.
Species	General	The vertebrates

Human rights	Animal rights
Freedom to Life	Right to be free from hunger
Freedom of Expression	Freedom from discomfort, pain and injury
Freedom of Belief	Freedom from fear and distress
Freedom of Association	Freedom to express normal behaviour

Criminal code on cruelty to animals

Sections 450, 495-499 of this Law forbids:

- Willful and unlawful killing, maiming and wounding of animals.
- Ill-treating and terrifying animals.
- Commission or omission to do any act and thereby causing unnecessary suffering to animals.
- Subjecting animal to any operation without due regard to care and humanity.

Penalty:

- Six months imprisonment or a fine of fifty naira or both.
- Police may take temporary custody of animal.
- Owner may be made to pay the cost of maintenance.

Sections 207-209 of this Law forbid:

- Ill-treating animals.
- Neglecting any animal as to cause unnecessary suffering.

Penalty:

- One year imprisonment.
- Police may take temporary custody of animal.
- Owner may be forced to pay the cost of maintenance

Aspects of ethics in animal research

General issues:

- Causing injury to animals without due care;
- Injection of poisonous drugs to animals;
- Neglecting animals;
- Allowing animals in captivity to starve;
- Transporting animals without due care;
- Conflict of interests.

Peculiar issues (to client-owned animals).

- Informed consent (client-owned animals).
- Anonymity of clinical data.
- Confidentiality of information on clients.

Recommendations on ethical issues in animal research

- Ethical Committee on animal research should be set up to consider research protocols and monitor these ethical issues.
- Obtain legal advise on acceptable ways to handle animals.
- Obtain veterinary assistance to avoid or ameliorate undue suffering to research animals.
- Plagiarism – don't be a literary thief.
  - If you use a phrase from someone else's work, place it in quote or indent it and state reference.
  - If you present tables or figures derived from someone else's work, indicate the source of data.

OTHER AREAS OF ETHICAL VIOLATIONS IN RESEARCH

Research does not terminate with data collection. The process extends beyond it. The following are some key areas in which abuse is common.

Plagiarism

Plagiarism is an act of literary theft. It refers to a situation in which a person steals and/or passes off the ideas, words, or findings of another researcher as his or hers. Thus, it is one of the most serious academic crimes that a professional can commit. Often the failure to acknowledge the true source of those ideas, words, or findings is enough to constitute plagiarism. In a scientific write-up, the reader should be able to distinguish easily between the author's thoughts, language, and ideas, and someone else's.

To avoid allegations of plagiarism, one should always put short quotations in inverted commas, with the full reference provided at the appropriate place. Should the quotation be longer, then it ought to be indented. Even paraphrased ideas should be duly acknowledged. The same principle holds for tables and figures that are not generated by primary research. Their sources should be indicated.

Falsification of Data

This refers to the practice of "cooking" data, or manipulating them to suit an expected pattern that was not empirically obtained.

Anonymity of Clinical Data

This covers the obligation of scientists not to disclose the identity or vital information of owners of animals used in veterinary research without their consent.

CONCLUSION

The convergence between clinical and social research with regard to ethics is apparent from the foregoing. This is partly accounted for by the prevailing interdisciplinary and transdisciplinary directions of modern scholarship. As new problems arise that demand research attention, multidisciplinary and multi-sectoral collaborations will increase. In the Nigerian field, the rising popularity of qualitative methods in the social sciences means that careful attention needs to be paid to the ethical implications (and possibilities) of this development. New ethical problems are emerging. Researchers will increasingly operate across spheres and become exposed to the same requirements in the conduct of research as might hitherto have been the exclusive preserve of individual disciplines. The need for a chapter on ethics in research, such as the present one, is therefore obvious.

With this in mind, energy should be directed toward strengthening the capacity of ERCs, IRBs, professional associations and communities to the enforcement of ethical rules among researchers. In particular, the capacity of the community to act as its own ethical gatekeeper should be developed. In the process, research scientists, participants, and institutional and community stakeholders should be prepared to adapt and apply ethical principles in research in a spirit of mutual commitment and partnership. As part of that commitment and partnership, they will confront several difficult dilemmas. Some of these dilemmas constitute a rehash of old epistemological questions, which arise when one conflates scientific research and moral philosophy: Is the gap between facts and values real, or just imagined? Is there a logical way to get from statements of fact to statements of value? Is evidence irrelevant to the making of value judgements, and can value judgements be justified by evidence? Should some other basis be sought for their separate justification, such as an appeal to faith or divine revelation, perhaps, or is this essentially an antinomic problem?

As noted earlier, there is no clear consensus on a complete set of ethical rules to be followed when conducting research involving human subjects – although there are some generally agreed professional guidelines. While this statement captures the prevailing mood, it does not indicate the future course of the development of ethics in research. Firmer statements need to be made, with appropriate sanctions to back them up. Otherwise, human subject research will remain prone to abuse.

At another level, collaborations between indigenous and expatriate investigators are presenting ethical worries of their own. A critical segment of the African scientific community is currently engaged in an open critique of "the 10/90 disequilibrium". This "disequilibrium" refers to the prevailing situation in which some 93 percent of the global burden of premature mortality due to disease occurs among late industrializers, while 95 percent of global health expenditure on health research is directed at disease in industrialized countries. But this disequilibrium also has ramifications in the social sciences, where the "consultant syndrome" alienates the African social scientist from problems affecting his or her own communities directly. He or she becomes a mere adjunct, a field appendage glorified by the title of "consultant", often solely because funding for the investigation has been obtained through the Northern "partners" to the research. Experience shows that, in terms of adequate knowledge of the field and state of the art, the disequilibrium is frequently skewed in the opposite direction – the partners with least money available frequently have most of the knowledge of the phenomenon under investigation available to them.

It is important to continuously review aspects of research that might undermine human well-being and dignity, especially as it is now clear that more research will need to be carried out as the world grapples with the numerous problems confronting it. Sensitivity to ethical breaches should expectedly be higher in Africa, since this is the site of a disproportionate amount of clinical and social investigations today. The modern research context has, accordingly, become a new arena for contesting the re-manifestations of racially influenced scientific malpractices. Emphasis should be placed on the reality of science as a social creation and human (and, therefore, humane) activity. The pursuit of knowledge ought not to justify the harm that scientific procedures might cause any research participants.

It is our hope that this chapter has helped raise greater sensitivity to the issues that have taken decades to develop, namely that research produces better scientific results if it is ethical. All research must, therefore, be governed by the three cardinal ethical principles of respect for persons, beneficence, and justice. Indeed, the protection of these principles should rank among the ultimate purposes of scientific research.

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16

CHALLENGES OF CONDUCTING RESEARCH IN DEVELOPING COUNTRIES

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INTRODUCTION

Some of the challenges in conducting research in developing countries are described in this Chapter. An example is given of the problems faced in conducting biological and medical researches.

Notion of Research

Research can mean one or more of the following activities:

- Free inquiry
- Painstaking search for the truth no matter where it leads
- Unfettered intellectual engagement aimed at expanding the frontiers of knowledge
- Unbiased recording and interpretation of events with a view to unveiling new facts or trends
- Knowledge mining of systems in the universe

RESEARCH IN THE CONTEMPORARY WORLD

Research occupies a strategic position as it is more important in wealth creation than the mere possession of raw materials because the key to sustainable socio-economic development comprises knowledge creation, processing, packaging and dissemination. Nations with poor research capacity must expect to regress and become poorer, since knowledge is expensive, while raw materials, with no value added, are relatively cheap.

In that case, a vicious circle is set up: poverty gives rise to poor research capacity, which in turn generates more poverty.

Today, Universities around the world are differentiated by, among other criteria,

- the level of their involvement in research
- the type of problems they attempt to solve
- the impact of any results they obtain on their societies and the world at large

As a result, many universities take great pains to promote research through the structures and facilities they make available and the way they continually empower their staff and students to engage in cutting-edge research activities. Universities which pay only lip service to research must expect to decline and be relegated in the congregation of higher education institutions.

Strategies for Sustainable Research Activities

Some of the strategic initiatives needed include:

- Building research capacity and synergy through
  - Good and implemented institutional policy on research;
  - Providing the enabling environment for research;
  - Enhancing the scope for intellectual, scientific discourse;
  - Making research a feature of various levels of training;
  - Formulating and implementing strategic national research policies;
- Promoting interdisciplinary/trans-disciplinary research collaborations;
- Making institutional research announcements, highlighting selected new developments or directions;
- Networking/collaborative activities involving various partners: industries, other research institutions, etc;
- Packaging and dissemination of research products.

Obstructions to Research Activities in Developing Countries

Attitudinal Issues

In their race to catch up with the developed countries overnight many developing countries fail to understand:

- the nature of the research enterprise;
- the long gestation periods of many research activities: the products we see on shelves in markets have taken years to get to the public;
- the expensive nature of research;
- the speculative nature of research;
- the need for continual and uninterrupted research engagement, as a strategy for sustainable development;
- the imperative of seeing research as a veritable strategy for sustainable development.

Poorly Articulated, or Obscure National Priorities

At independence, several developing countries had some clearly stated national priorities although they had only a few indigenous researchers; ironically, some forty years down the road when the countries have many experts, they have no identifiable national priorities.

That research is not a priority in many developing countries is seen in the fact that many of them, like Nigeria, do not have crucial outfits such as: national science foundations to support mission-oriented research

Substantial Loss of Sovereignty by Many Developing Countries

Developing countries are mere puns on the chess boards of foreign organizations like the: IMF, World Bank, Paris Club, and WTO which supervise their activities on almost a daily basis. This makes it difficult for developing countries to set meaningful national priorities.

Developing countries have been oriented to look outwards for turnkey solutions to their problems, instead of searching for autochthonous or endogenous solutions. This leads to the abandonment of, or ineffectual support for, research activities by many developing countries and poor states of research infra-structure in the form of

- libraries,
- laboratories,
- facilities/funds for field trips, surveys, etc, and
- ICT infrastructure, hindering connectivity to the global information pool.

There is difficulty in obtaining vital data from statutory national agencies and

- data collection, structuring, and warehousing often not done to ensure quick retrieval;
- negligence in data collection and warehousing;
- poor, or no data security measures in place;
- data often of doubtful integrity owing to indolence, incompetence, corruption, etc;
- data often not timely; and
- official secrets act.

Mentoring of Young Researchers

Severe personnel constraints arising from bad policies invariably lead to competent persons not being available for mentoring; hence, there is a lack of poor interest in research by many young persons and incompetent mentors.

There are limited outlets for research works because:

- escalating international standards means that many young researchers cannot publish in international journals;
- cost of publishing in some international journals may be high, and unaffordable by researchers;
- cost of publishing in local journals is escalating;
- local journals are often obscure and hardly widely distributed;
- local journals have high mortality rates;
- many local journals have poor scholastic quality.

International experience is inadequate or vanishing because of lack of funds for conferences, fellowships, staff training, etc. These are mainly supported by foreign agencies, hence highly competitive, with conditionalities.

The consultancy syndrome has resulted in rushed data collection and analysis and data manipulation to meet clients' expectations.

Collaboration/networking with foreign partners

Institutions in developing countries are seen by foreigner scientists as mere outposts for data collection, hence home scientists are relegated to the subordinate role of data collection while the academic/intellectual role is assumed by the foreign partner.

Only data that support some predetermined position held by foreign partners are considered valid/acceptable and therefore, reports are prepared to conform with the views/ expectations of the foreign partners.

The wages of underdevelopment are manifested in

- Poor municipal and other facilities such as
  - Electricity
  - Water supply
  - Roads and transportation and
  - Lack of security.
- High inflation in the economy.
- Shifting economic paradigms (SAP, deregulation, etc).
- Widespread corruption
- Fake and adulterated products

Ethical Issues

Young researchers have little or no knowledge about the ethics of research, hence unethical practices in research are increasing in the form of

- manipulation and falsification of data,
- reporting experiments that were never done,
- results that are not reproducible,
- lack of truth and trustworthiness in research

These arise from compromised peer-review system and unethical practices in the larger society

WTO/GATS/TRIPS and research

- Commodification of knowledge
- Withdrawal/reduction of public support for research in higher education institutions
- Trade-Related Aspects of Intellectual Property Rights (TRIPS): patents, trademarks, and copyright issues
- Foreign domination of developing countries
- Emphasis will be on commercial research

Some fall-outs from the difficulties in doing research in developing countries include the following:

- **Polemic** responses to intellectual discourse
- Research is often merely **mimetic**, with no depth, **foundation** or **relevance**: this means that research hardly addresses key development issues
- Poor **quality** of research output
- Progressive enthronement of **mediocrity**
- **Brain drain**

CONSTRAINTS TO ACADEMIC LINKAGES

The main obstacle to conducting research in developing countries can be attributed to inadequate institutional funding (Ekhaguere 2004). Arising from this are such other problems as the following:

- poor teaching, learning and research environments, evident in the poor state of libraries, laboratories and the ICT infrastructure,
- poor living conditions of staff and students
- incessant strikes by university staff unions which lead to disruptions in academic calendars.
  - It has been reported (Abubakar 2003) that the nationwide strike embarked on by the Academic Staff Union of Universities (ASUU) from January to May 2003 led to a financial loss of some N43.3 billion.
  - Other losses include the loss of worth of our certificates, knowledge, skills and overseas' scholarships.
- inadequate resource provision for inter-institution cooperation
- poor quality staff (teaching, technical and administrative)
- lack of scholarship and bursaries to the vast majority of students
- poverty among students, leading to many cases of those who are registered as full-time students but are at the same time working full-time/part-time
- declining ethical and moral values,
- inadequate staff development activities,
- rising scourge of the HIV/AIDS pandemic on

campuses,
- poor state of campus facilities such as roads, water supply, and electricity supply,
- unsafe campus environment and endemic campus violence,
- poor campus sanitation.

The challenges in conducting research in Nigeria can be grouped into two main classes:
- those caused by the proprietors,
- those that are self-inflicted.

The political and economic crises of the last 20 years or so have caused social dislocations, resulting in:
- inadequate funding,
- inadequate human resources,
- loss of the academic ideals, ethics and transparency.

Government has never treated universities as worthy partners. Universities are neither encouraged nor challenged to play constructive roles in research and development, through generous discretionary funding from government. Nigerian universities as corporate bodies are hardly involved in projects that are sponsored by government.

In developed countries, universities are major contractors to government because they bid for projects that provide the basis for the knowledge that is to be used to move society forward. Postgraduate students in turn work on the projects that are headed by their professors

Reforms are needed to recover the academic ideals, but these must be democratic in nature. These will entail:
- constructive criticism
- consultation
- participation in decision making by individuals and units
- academic freedom

What is required:
- academic mentoring
- peer criticism

- quality assurance in publications
  - definition of publications has been so lax in many cases, more so in these days of desktop publishing.

MENTORING

The word mentor can be employed to mean:

- a trusted counsellor,
- guide
- tutor or coach

usually older (and/or more experienced) than the person being counselled, guided or tutored. The number of experienced academic staff who are willing to be mentors is grossly inadequate (table 1). The younger academic members are overworked and find little time for personal professional development beyond the required postgraduate degrees (Sonaiya 2004). Opportunities to attend learned conferences are limited

Table 14.1:
Distribution of academic staff by grade in the University of Ibadan, as at December 2003.

Grade	Number of staff
Assistant Lecturer	101
Lecturer II	253
Lecturer I	222
Senior Lecturer	295
Reader	27
Professor	249
Total	1147

Source of data: Osasona and Olayinka (2004)

PASSION FOR RESEARCH

In order to produce excellent results, a researcher must believe passionately in what s/he is doing. There are reported cases of many academics even in developed countries of the world who have all the necessary facilities at their disposal, but who lost interest in any serious research once they obtained tenure (Spittler 2004). Conversely, there are many badly equipped researchers who work in an environment that is indifferent or hostile to their research, who still manage to do excellent work. The latter group ought to be encouraged and some of them may be interested in doing fundamental research. They most certainly need to network (e.g. by e-mail) with people who share similar opinion.

It would seem that from about 1985 till 2000 many young scholars were not interested in having a career in universities or research institutes largely on account of the very poor salaries and lack of research facilities. Some of the most popular and imaginative slogans, developed by ASUU, and which members displayed on their office doors and as car stickers were "My take home pay cannot take me home", "My boss is a comedian, the wages he pays is a joke". I think the "boss" in the latter should in fact read "employer". Employment within the Nigerian university system became very unattractive to most potential scholars. The private sector, especially the banking sub-sector and oil exploration and production companies offer much better attractions. In such circumstances it became very difficult for young scholars to have any enduring passion for research.

It might be encouraging to start an academic career if universities teaching and research are prestigious activities within the society. Even if the income prospects are lower than for persons engaged in the private sector, it may still be attractive to plan for an academic career. For example in Germany, a university professor ranks high in society. There, a university professor always ranks highest, followed by doctors and pastors, and far higher than politicians (Spittler 2004).

STRENGTHENING COLLABORATION BETWEEN UNIVERSITIES

Some of the measures that can help in fostering inter-university collaboration include the following:

- strategic planning
- striving for excellence in teaching and research
- improving the ICT infrastructure
  - For a university to be in a position to compete

favourably in the present-day world, the need for a functional and robust website cannot be overemphasized
- Apart from other information, it is necessary to showcase the reservoir of expertise that abounds within the university.

- improving the state of infrastructure on the campuses (roads, water supply, electricity supply, telecommunication)
- regularizing the academic calendar
- improving ethical standards in teaching and research
- recognizing credits for studies abroad
- operating a functional international relations office
- internationalizing the curriculum
- dealing with policy and management issues
- broadening participation in regional initiatives (e.g. NEEDS, NEPAD, AGOA)

There is an urgent need to strengthen inter-university cooperation in Nigeria in order to promote academic mobility within the country. This will also foster national and international inter-university collaboration in research projects.

The following are some of the factors that may constitute obstacles to productive research.

Researcher's Factors
- lack of conviction
- lack of focus
- unclear motives
- fear of failure
- poor motivation

Supervisor's Factors
- lack of interest
- poor mentoring
- poor remuneration
- frustrations

Institutional Factors
- poor motivation

- unrealistic institutional policies
- lack of reward for excellence
- defective information system
- lack of commitment
- national factors!!!

Six Phases of a Research Project

- enthusiasm
- disillusionment
- panic
- search for the guilty
- punishment of the innocent
- praise for the non-participant

CHALLENGES OF CONDUCTING RESEARCH IN BIOLOGICAL AND MEDICAL SCIENCES IN DEVELOPING COUNTRIES

Introduction

A significant number of research studies have been conducted in the developing world, as can be observed by the contributions to published scientific and biomedical literature. However, the results of most of such studies seem to be less likely to be published in international journals, particularly in influential scientific journals, compared with reports from similar institutions in developed countries. Allusions have been made, in some international and local circles, to the effect that studies and research for development in biological and medical sciences in the developing countries have been largely inefficient, ineffective and unable to attract commendable international acclaim worthy of say, Nobel Prize or such likes. This is due to the fact that they have been plagued by factors attributable to the following:

- There are usually no policy-driven quest for scientific research in the quantum needed, and neither are there incentives to create the enablement and zeal by scientists to carry out scientific research; Most of these countries prefer to import scientific results and technology at great cost.
- Many of these studies have not investigated major

scientific and medical innovations aimed at solving national problems, but have focused on less significant problems, or at best a replication of studies carried out elsewhere.

- Most of the well-researched, result-oriented studies have been external donor-driven, usually catering to the priorities of donor agencies, instead of national priorities.
- The quality of research in many instances is lower.
- The information generated from such researches have not been well documented, disseminated and put to use by policy- and decision-makers at all levels of governance and sectors of society.

The Challenges

Although there may be some substance in the above assertions, it is also true that in most developing countries, researchers have to do their work under extremely difficult conditions. The challenges facing these researchers can be grouped into four categories: the macro-environment, work environment, personal factors and the intrinsic and specific nature of biological and medical research.

The Macro-environment

A fundamental determinant of the level of scientific research capability and activity in developing countries is the general social, economic and political environment. Apart from lack of political will by leaders in most developing nations for basic scientific and applied research, prolonged military rule, natural disasters such as famine and drought, man-made disasters such as civil wars and wars with neighbouring countries, international economic recession and local administrative mishaps have changed (and continue to change) the socio-economic landscape of these countries. Such political, economic and social instabilities are obviously not conducive to fruitful research activities.

Another challenge is the lack of demand for (and social appreciation of) research from developing countries. Policy- and decision-makers do not demand and utilize results of most scientific findings. At best, when requested for, the results of the probably poorly funded researches end up in filing cabinets.

In countries where there is a semblance of democratic rule, the public and politicians who represent them are not aware of the utility of research. The main reason for this is a low level of scientific culture, due to underdevelopment, high level of illiteracy and absolute poverty in these nations, especially in sub-Saharan Africa.

Resource allocation for scientific research from public funds is essential if research is to be of use for national development. However, few governments in the developing world are willing to allocate a sizeable amount of resources for research in general and for biomedical research in particular. Because of limited funding from the public sector, researchers have a restricted choice of topics, and thus are frequently unable to institute research into wider problem areas. Where external funding is available, the objectives of investigations are usually dictated by donors, and results used for their own selfish ends.

The Work Environment

The research infrastructure in low-income countries is generally weak. Inadequate and insecure budgets, inadequate equipment and supplies and scarcity of technicians and support staff are commonplace. Until recently, in areas where there is development of internet-based information communication technology, limited access to up-to-date journals and books in their particular disciplines is probably the greatest challenge facing most researchers. Literature review is essential in order to be able to study the background to a particular research problem, to justify research proposals, to avoid 're-inventing the wheel', and to write good reports. Particularly in Nigeria, the internet is expected to alleviate this problem, but research staff with computer and internet facilities are still in a small minority.

Because of the low level of development of human resources in biomedical sciences in developing countries, particularly in Nigeria, the number of skilled researchers is limited and the exchange of experience between investigators is either impossible or is extremely limited.

Lack of, and if present, inadequate and poor infrastructural facilities such as uninterruptible power and water supplies are a bane to any scientific and biomedical research. The inept national power supply and backup systems do not guarantee effective temperature-dependent research and storage of laboratory reagents and biologicals, not to talk of uninterruptible and timed research protocols. The loss and psychological frustration a scientist suffers when there is power outage during a research work or surgical operation are better imagined. Catastrophic losses have been and are still being encountered in avoidable destruction of valuable biologicals in most biomedical research laboratories nationwide. Frequent and epileptic power and water supplies have led to avoidable loss of sensitive scientific equipment in many laboratories. There is a dearth of modern equipment, and old ones when available are no longer serviceable because the manufacturers have long phased them out of their production lines. The few modern equipment available are always jealously guided by their owners because of insecurity. In most universities, and notably Ibadan, there is no central research laboratory where maximum advantage of the few scattered equipment can be tapped and the over-blown well trained laboratory staff can be put into effective use.

Personal factors

Relatively low salaries and emoluments of researchers are a major and perennial problem in developing economies. This has forced a considerable number of most of the highly trained (mostly overseas trained) researchers and scientists to seek greener pastures either in developed countries or developing countries where the pay packet is bulkier. This is the popular brain-drain syndrome, which to date is still in force. Most of the few well-trained scientists who choose to remain at home devote substantial amounts of their time to other income-generating activities such as private practice and consultancies instead of research.

The vast majority of the younger scientists who carry out research in developing countries, especially in Nigeria in the last 15-20 years, are products of in-breeding by senior colleagues, who either studied here or at best enjoyed overseas training in the late 70's or early 80's, when things were much better than now. This phenomenon has placed a lot of restrictions on the quality and quantity of scientific findings, up-to-date equipment and infrastructural facilities for good research.

Insufficient training of staff working in scientific and medical laboratories, protocol development, fund soliciting, project execution and financial management is another challenge. Although these workers may be highly skilled in their respective disciplines, few have had the necessary training to plan and implement research projects.

Intrinsic Nature of Biomedical Research

Biomedical research comprises of fields of study that are implicitly exact in their form and outlook. They are not only basic; most of the research results are applicable to life and living. In almost all cases, they determine life and death of persons, plants and animals; essentially life and existence on mother earth. No amount of semantics and philosophy can add to or remove from the significance of biomedical research findings. In essence, results of biomedical research may not be varied to suit purposes for which they are not intended. Hence, they require specialised equipment, well trained staff and a good and efficient work environment for good results.

Conclusion

The problems that have plagued research in biomedical sciences in most developing countries are not insurmountable. Despite the multitude of challenges facing them, probably the most important incentive for researchers in developing countries is their conviction that they are working in places where the need for their research is greatest, and that at some future date (hopefully soon) policy- and decision-makers will recognize the need for research and development in biomedical sciences as priority areas that need adequate resource allocation, and that the results of their research will be used to improve the living conditions of individuals, families and communities in these countries.

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Appendix 1

Definitions of research on the Web

systematic investigation to establish facts
www.cogsci.princeton.edu/cgi-bin/webwn

a search for knowledge; "their pottery deserves more research than it has received"
www.cogsci.princeton.edu/cgi-bin/webwn

inquire into
www.cogsci.princeton.edu/cgi-bin/webwn

attempt to find out in a systematically and scientific manner; "The student researched the history of that word"
www.cogsci.princeton.edu/cgi-bin/webwn

Systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. (45 CFR 46.102(d)) FDA regulations define research as clinical investigation, which is any experiment that involves a test article and one or more human subjects and that either is subject to requirements for prior submission to the FDA or which is intended to be submitted later to the FDA as part of an application for a research or marketing permit. (21 CFR 50.3(c))
www.aahrpp.org/definitions.htm

A systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge. Activities that meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program, which is, considered research for other purposes. For example, some demonstrations and service programs may include research activities.
www.clemson.edu/research/orcSite/orcIRB_DefsR.htm
a systematic investigation designed to develop or contribute to general knowledge. Activities, which meet this definition, constitute "research," whether or not they are supported or funded

under a program that is considered research for other purposes. For example, some "demonstration" and "service" programs may include research activities 45 CFR 46.102(d)
www.irb.purdue.edu/definiti.shtml

is systematic study directed toward more complete scientific knowledge or understanding of the subject studied. The federal government classifies research as either basic or applied according to the objective of the sponsoring agency.
www.aaas.org/spp/rd/define.htm

A systematic investigation, including research development, testing and evaluation, designed to develop or to contribute to generalizable knowledge.
www.gulflink.osd.mil/medsearch/glossary/glossary_r.shtml

A systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalizable knowledge.
healthcare.partners.org/phsirb/hipaaglos.htm

means a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge.
www.preemptinc.com/definitions.html

focused, systematic study and investigation undertaken to increase knowledge and understanding of a subject. At SIUC, the term is used inclusively to refer to scholarly, empirical, creative, critical, and/or expressive activities in the sciences, humanities, arts, and other scholarly fields, which expand, clarify, reorganize, or develop knowledge or artistic perception. Includes Research training. Research may be basic or applied.
www.siu.edu/orda/general/glossary.html

Research is systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research is classified as either basic or applied according to the objectives of the sponsoring agency. See also Research, development,

and R&D plant.
www.nsf.gov/sbe/srs/fedfunds/glossary/def.htm

All expenditures for activities specifically organized to produce research outcomes. This includes: Institutes and research centers, and individual and project research. (NACUBO)
www.bgtplan.lsu.edu/trend/glossary/gloss.htm

A systematic investigation (i.e., the gathering and analysis of information) designed to develop or contribute to general knowledge.
www.rush.edu/research/patients-definition.html

Interpreted in RSP 111, "Misconduct in Research," to include scholarship and creative work, as well as scientific research.
www.asu.edu/aad/manuals/rsp/rsp004.html

All expenditures for activities specifically organized to produce research outcomes. This includes: Institutes and research centers, and individual and project research.
www.selu.edu/Administration/Inst-Research/Glossary.htm

This category should include all expenditures for activities specifically organized to produce research outcomes, whether commissioned by an agency external to the institution or separately budgeted by an organizational unit within the institution. Subject to these conditions, it includes expenditures for individual and/or project research as well as those of institutes and research centers. This category does not include all sponsored programs (training grants are an example) nor is it necessarily limited to sponsored research, since internally supported research programs, if separately budgeted, might be included in this category under the circumstances described above. Expenditures for departmental research that are separately budgeted specifically for research are included in this category.
www.boisestate.edu/research/functional%20definitions.htm

A systematic investigation, including research development, testing and evaluation, designed to develop or to contribute to

generalized knowledge." Topic areas:Fundraising and Financial Sustainability
www.nonprofitbasics.org/TopicAreaGlossary.aspx

Funds to cover the costs of investigations and clinical trials, including demonstration and pilot projects. (Research grants for individuals are usually referred to as fellowships.)
gtionline.fdncenter.org/gti_help/1glosary.htm

means systematic investigation designed to develop or contribute to generalizable knowledge. Under this definition some demonstration, service and training projects may be considered to include research activities.
www.iup.edu/graduate/irb/defnabbr.shtm

A systematic investigation, including research development, testing and evaluation, designed to develop or contribute to generalized knowledge.
www.nwhealth.edu/research/irb/irbgoals.html

The collecting of information about a particular subject.
nces.ed.gov/NCESkids/Glossary.asp

A form of inquiry that involves seeking of evidence to increase knowledge. A systematic process for recognizing a need for information, acquiring and validating that information, and deriving conclusions from it.
www.seattlecentral.org/library/101/textbook/glossary.html

investigation and experimentation aimed at discovery, interpretations, and application of scientific data
pharmacy.ucsf.edu/glossary/

research and development (R&D) which involves more than one technical discipline or program area in order to be fully successful; also multi- or inter-disciplinary R&D.
energytrends.pnl.gov/glosn_z.htm

a systematic study directed toward more complete scientific knowledge or understanding of the subject studied. The federal

government classifies research as either basic or applied according to the objective of the sponsoring agency.
www.esb.utexas.edu/surge/Resources&Links/glossary.htm

Many varieties and categories of research are relevant to dietary supplements. See clinical trial, control group, double-blind study, in-vitro research, peer review, placebo, randomized controlled trial, single-blind study, treatment group.
www.supplementquality.com/glossary.html

When an activity involving a patient is undertaken with the prime purpose of testing a hypothesis and permitting conclusions to be drawn with the intention of contributing to medical knowledge, it becomes research.
www.mrc.ac.za/ethics/definitions.htm

Appendix 2

Qualitative Researching

1. Interviewing – 'conversation with a purpose'
Choice of interviewing presupposes that your ontological position is that people's knowledge, views understandings, interpretations, experiences and interactions are meaningful properties of the social reality which your research questions are designed to explore. Also that knowledge is constructed rather than excavated. People's perceptions are of interest; their constitution of language or discursive construction of the social or self is very interesting.
2. It is a legitimate way to generate data – It is interactive, you ask them questions, listen to them, their accents, articulation; when do they laugh, reiterates stress, say things in a dismissive or emphatic way "some things are done/not done/said/not said.
3. The context of the information is essential, so is the situation, and the interaction; there are no abstract questions or one size fits all; specific examples (Is it constructive? Is it subversive?) It also gives "voice" to the people behind the statistics.
4. In Focus Group Discussions (FGDs) – you guide group discussion through a particular set of topics; you have to be sensitive to the dynamics of each interaction; you take cues from answers, since interviews are not pre-scripted.
5. You are not a neutral data collector. In a face-to-face situation, your voice, gestures, facial expressions matter.
6. Structured interviews/questionnaires are often designed to minimize "bias" through standardization of questions asked, the way they are asked and the interviewers who ask them. Assumption is that <u>bias</u> can be eradicated.
7. Interviews are suited for questions of social process,

change, where you want to elicit nuance, depth.

8. Unlikely to rely heavily on quantifying, (though frequency counts are possible) more conceptual than inductive.
9. Also indicates your view of research ethics and politics – which allows interviewees more freedom and control of interview situation and represent their views more fully and fairly.

Source: Jennifer Mason 2002 Qualitative Researching (2nd. Ed.) London: SAGE Publications

Appendix 3

Glossary of research methods terms

Retrieved 9 July 2004 from *http://www.bath.ac.uk/e-learning/gold/glossary.html*

Audit trail , *Attrition* , *Bias* , *Bracketing* , *Categorical variable* , *Central tendency* , *Clinical trial* , *Coding* , *Confidence interval* , *Confounding variable* , *Constant comparative method* , *Content analysis* , *Continuous variable* , *Control* , *Core category* , *Correlation* , *Correlation coefficient* , *Data saturation* , *Deductive reasoning* , *Dependent variable* , *Descriptive statistics* , *Determinism* , *Emic perspective (emic view)* , *Ethnography* , *Ethnomethodology* , *Etic perspective (etic view)* , *Experimental research* , *Experimental group* , *Extraneous variable* , *Field notes* , *Focus group* , *Frequency distribution* , *Grounded theory* , *Hypothesis* , *Independent variable* , *Inductive reasoning* , *Inferential statistics* , *Informed consent* , *Interrater reliability (interobserver reliability)* , *Interview* , *Structured interview* , *Unstructured interview* , *Likert scale* , *Mean* , *Measurement scale* , *Median* , *Meta-analysis* , *Method slurring* , *Mode* , *Naturalistic paradigm* , *Negative correlation* , *Nonparametric statistics* , *Nonsignificant result* , *Null hypothesis* , *Observation* , *One-tailed test* , *Operational definition* , *p value* , *Paradigm* , *Parameter* , *Parametric statistics* , *Phenomenology* , *Population* , *Positive correlation* , *Positivism* , *Qualitative data* , *Quantitative data* , *Quasi-experiment* , *Randomisation* , *Randomised controlled trial (RCT)* , *Random sampling* , *Range* , *Reliability* , *Research methodology* , *Research method* , *Research question* , *Response rate* , *Sampling* , *Sampling bias* , *Sampling error* , *Sampling frame* , *Significance level* , *Standard deviation* , *Statistic* , *Statistical analysis* , *Statistical inference* , *Statistical significance* , *Statistical test* , *Subjects* , *Survey research* , *Test-retest reliability* , *Theme* , *Theoretical framework* , *Theoretical notes* , *Theory* , *Triangulation* , *Trustworthiness* , *Type I error* , *Type II error* , *Validity* , *Variable* , *Variance*

Audit trail
The systematic presentation of material gathered within a naturalistic study that allows others to follow and audit the researcher's thinking and conclusions about the data.

Attrition
A reduction in the number of participants during the course of a study. If more participants withdraw from one group than another group, this can introduce bias and threaten the internal validity of the research.

Bias
Any influence that distorts the results of a research study.

Bracketing
A process used by researchers working within the Husserlian phenomenological tradition to identify their preconceived beliefs and opinions about the phenomenon under investigation in order to clarify how personal biases and experience might influence what is seen, heard and reported.

Categorical variable
A variable with discrete values (e.g. a person's gender or a person's marital status).

Central tendency
A measure of the typicality or centrality of a set of scores; the three main measures of central tendency are mean, median and mode.

Clinical trial
A large-scale experiment designed to test the effectiveness of a clinical treatment.

Coding
A procedure for transforming raw data into a standardised format for data analysis purposes. Coding qualitative data involves identifying recurrent words, concepts or themes. In positivist research, coding involves attaching numerical values to categories.

Confidence interval
A confidence interval identifies a range of values that includes the true population value of a particular characteristic at a specified probability level (usually 95%).

Confounding variable
A variable, other than the variable(s) under investigation, which is not controlled for and which may distort the results of experimental research.

Constant comparative method
A procedure used during grounded theory research whereby newly gathered data are continually compared with previously collected data in order to refine the development of theoretical categories.

Content analysis
A procedure for organising narrative, qualitative data into emerging themes and concepts.

Continuous variable
A variable that can take on an infinite range of values along a specific continuum (e.g. weight, height).

Control
Processes employed to hold the conditions under which an investigation is carried out uniform or constant. In a true experimental design, the control group is the group that does not receive the intervention or treatment under investigation. The scores on the dependent variable for the control and the experimental groups are used to evaluate the effect of the independent variable. In other experimental designs, this group may be referred to as the comparison group.

Core category
The central category that is used to integrate all the categories identified in grounded theory research.

Correlation
The degree of association between two variables. A tendency for variation in one variable to be linked to variation in a second variable.

Correlation coefficient
A measure of the degree of relationship between two variables. A correlation coefficient lies between +1.0 (indicating a perfect positive relationship), through 0 (indicating no relationship between two variables) to -1.0 (a perfect negative relationship).

Data saturation
The point at which data collection can cease. This point of closure is arrived at when the information that is being shared with the researcher becomes repetitive and contains no new ideas, so the researcher can be reasonably confident that the inclusion of additional participants is unlikely to generate any new ideas. (Sometimes simply referred to as saturation.)

Deductive reasoning
A logical process of developing specific predictions (hypotheses) from general principles. This type of reasoning moves from the general to the particular.

Dependent variable
In experimental research, the dependent variable is the variable presumed within the research hypothesis to depend on (be caused by) another variable (the independent variable); it is sometimes referred to as the outcome variable.

Descriptive statistics
Statistical methods used to describe or summarise data collected from a specific sample (e.g. mean, median, mode, range, standard deviation).

Determinism
The belief that everything is caused by specified factors (antecedent factors) in a predictable way rather than haphazardly; a key assumption within the positivist paradigm.

Emic perspective (emic view)
A term used by ethnographers to refer to the insider's or native's view of his or her world (see also etic perspective).

Ethnography
A research methodology associated with anthropology and sociology that systematically describes the culture of a group of people. The goal of ethnographic research is to understand the natives'/insiders' view of their own world (an emic view of the world).

Ethnomethodology
Systematic study of the ways in which people use social interaction to make sense of their situation and create their 'reality'. This research methodology, associated with sociology, focuses on how people understand their everyday activities.

Etic perspective (etic view)
A term used by ethnographers to refer to the outsider's view of the experiences of a specific cultural group (see emic perspective).

Experimental research
A research methodology used to establish cause-and-effect relationships between the independent and dependent variables by means of manipulation of variables, control and randomisation. A true experiment involves the random allocation of participants to experimental and control groups, manipulation of the independent variable, and the introduction of a control group (for comparison purposes). Participants are assessed before and after the manipulation of the independent variable in order to assess its effect on the dependent variable (the outcome).

Experimental group
In experimental research the group of subjects who receive the experimental treatment or intervention under investigation.

Extraneous variable
A variable that interferes with the relationship between the independent and dependent variables and which therefore needs

to be controlled for in some way.

Field notes
Notes taken by researchers to record unstructured observations they make 'in the field' and their interpretation of those observations.

Focus group
An interview conducted with a small group of people to explore their ideas on a particular topic.

Frequency distribution
A visual display of numerical values ranging from the lowest to the highest, showing the number of times (frequency) each value occurs.

Grounded theory
A research approach used to develop conceptual categories/ theory about social processes inductively from real-world observations (data) from a selected group of people. The researcher may subsequently make further observations to test out the developed categories/theory.

Hypothesis
A statement that predicts the relationship between variables (specifically the relationship between the independent and dependent variables). A hypothesis may be directional or non-directional:
Directional hypothesis (or one-tailed hypothesis)

A hypothesis that makes a specific prediction about the nature and direction of the relationship between the independent and dependent variables.

Non-directional hypothesis (or two-tailed hypothesis)
A hypothesis that does not specify the nature and direction of the relationship between the independent and dependent variables.

Independent variable
The variable (or antecedent) that is assumed to cause or influence

the dependent variable(s) or outcome. The independent variable is manipulated in experimental research to observe its effect on the dependent variable(s). It is sometimes referred to as the treatment variable.

Inductive reasoning
A logical process of reasoning used to develop more general rules from specific observations; this type of reasoning moves from the specific to the more generalised.

Inferential statistics
Statistics that allow a researcher to make inferences about whether relationships observed in a sample are likely to occur in the wider population from which that sample was drawn. Inferential statistics use logic and mathematical processes in order to test hypotheses relating to a specific population based on data gathered from a sample of the population of interest.

Informed consent
The process of obtaining voluntary participation of individuals in research based on a full understanding of the possible benefits and risks.

Interrater reliability (interobserver reliability)
A measure of the consistency between the ratings/values assigned to an attribute that is being rated or observed; it is usually expressed as a percentage of agreement between two raters/observers or as a coefficient of agreement which may then be expressed as a probability.

Usually employed by researchers using structured observation techniques.

Interview
A method of data collection involving an interviewer asking questions of another person (a respondent) either face-to-face or over the telephone.

Structured interview
The interviewer asks the respondents the same questions using

an interview schedule - a formal instrument that specifies the precise wording and ordering of all the questions to be asked of each respondent.

Unstructured interview
The researcher asks open-ended questions which give the respondent considerable freedom to talk freely on the topic and to influence the direction of the interview since there is no predetermined plan about the specific information to be gathered from those being interviewed.

Likert scale
A method used to measure attitudes, which involves respondents indicating their degree of agreement or disagreement with a series of statements. Scores are summed to give a composite measure of attitudes.

Mean
A descriptive statistic used as a measure of central tendency. All scores in a set of scores are added together and divided by the number of subjects.

Measurement scale
Measurement of a phenomenon or property means assigning a number or category to represent it. The methods used to display and/or analyse numerical (quantitative) data will depend on the type of scale used to measure the variable(s). There are four scales of measurement: nominal, ordinal, interval or ratio. The data associated with each measurement scale are referred to as nominal data, ordinal data, interval data and ratio data respectively.
Nominal scale the lowest level of measurement that involves assigning characteristics into categories which are mutually exclusive, but which lack any intrinsic order (e.g. classification by gender or by the colour of a person's hair or eyes)
Ordinal scale these categories can be used to rank order a variable, but the intervals between categories are not equal or fixed (e.g. strongly agree, agree, neither agree nor disagree, disagree, strongly disagree; social class I professional, II semi-professional, IIIa non-manual, IIIb manual, IV semi-skilled, and

V unskilled). Interval scale the categories are ordered and there are equal intervals between points on the scale, but the zero point on the scale is arbitrary so that a particular measure cannot be said to be 'twice as' large as another measure on the same scale (e.g. degrees Centigrade).

Ratio scale scores are assigned on a scale with equal intervals and also a true zero point (e.g. measurement in yards, feet and inches or in metres and centimetres).

Median
A descriptive statistic used to measure central tendency. The median is the score/value that is exactly in the middle of a distribution (i.e. the value above which and below which 50% of the scores lie).

Meta-analysis
A statistical technique for combining and integrating the data derived from a number of experimental studies undertaken on a specific topic.

Method slurring
This term is used to describe the tendency of some researchers to combine qualitative research approaches without adequately acknowledging the epistemological origins and assumptions that underpin the methodologies they are blending.

Mode
A descriptive statistic that is a measure of central tendency; it is the score/value that occurs most frequently in a distribution of scores.

Naturalistic paradigm
This paradigm assumes that there are multiple interpretations of reality and that the goal of researchers working within this perspective is to understand how individuals construct their own reality within their social context.
Negative correlation
A relationship between two variables where higher values on

one variable tend to be associated with lower values on the second variable; sometimes referred to as an inverse relationship (e.g. age of non-vintage cars and their market value).

Nonparametric statistics
Statistical tests that can be used to analyse nominal or ordinal data; they involve fewer rigorous assumptions about the underlying distribution of variables.

Nonsignificant result
The result of a statistical test which indicates that the outcome of an experimental research study could have occurred through random variation (or chance) at a specified level of significance, rather than as a result of manipulation of the independent variable.

Null hypothesis
A statement that there is no relationship between the independent and dependent variables and that any relationship observed is due to chance or fluctuations in sampling.

Observation
A method of data collection in which data are gathered through visual observations.
Structured observation
The researcher determines at the outset precisely what behaviours are to be observed and typically uses a standardised checklist to record the frequency with which those behaviours are observed over a specified time period.

Unstructured observation
The researcher uses direct observation to record behaviours as they occur, with no preconceived ideas of what will be seen; there is no predetermined plan about what will be observed.

One-tailed test
Used by a researcher when testing a directional (or one-tailed) hypothesis, this type of test of statistical significance uses only

one tail of an underlying distribution of scores/values to determine significance.

Operational definition
The procedures or operations used to observe or measure a specific concept. Operationalisation is the process of translating specific research concepts into observable phenomena that are measurable.

p value
p is the symbol for the probability that is associated with the outcome of a test of the null hypothesis (i.e. it is the probability that an observed inferential statistic occurred through chance variation). If the p value is less than or equal to the stated significance level - often set at 5% ($p < 0.05$) or 1% ($p < 0.01$) - then the researcher concludes that the results are unlikely to have occurred by chance and are more likely to have occurred because of the manipulation of the independent variable; the results are said to be 'statistically significant'. If the p value is greater than the significance level, the researcher concludes that the results are likely to have occurred by chance variation, and the results are said to be 'non-significant'.

Paradigm
Kuhn defines a paradigm in two ways: first as the entire constellation of beliefs, values and techniques shared by a scientific community; and secondly as the procedures used to solve specific problems and take theories to their logical conclusion. Kuhn also suggests that paradigms function as maps or guides, dictating the kinds of problem/issue which are important to address, the kinds of theories or explanations that are regarded as acceptable, and the kinds of procedure that are used to tackle particular problems.
Guba and Lincoln (1998, p.195) argue: 'From our perspective, both qualitative and quantitative methods may be used appropriately with any research paradigm. Questions of method are secondary to questions of paradigm, which we define as the basic belief system or worldview that guides the investigator, not only in choices of method but in ontologically and epistemologically fundamental ways'. They go on to assert:

'Paradigm issues are crucial; no inquirer ? ought to go about the business of inquiry without being clear about just what paradigm informs and guides his or her approach (p.218). [Reference: Guba, E.G. and Lincoln, Y.S. (1998) 'Competing paradigms in qualitative research', in Denzin, N.K. and Lincoln, Y.S. (editors) The landscape of qualitative research: theories and issues, Thousand Oaks, California: Sage, pp.195-220]
For the purpose of the distance learning research modules, we use the term paradigm to denote a worldview based on a set of values and philosophical assumptions that are shared by a particular academic community and that guide their approach to research.

Parameter
A characteristic of a population (e.g. the mean age of all nurses studying the MSc in Nursing by distance learning with the RCN Institute).

Parametric statistics
A type of inferential statistic that involves the estimation of at least one parameter. Such tests require either interval or ratio data and involve a number of assumptions about the variables under investigation including the fact that the variable is normally distributed.

Phenomenology
A research methodology which has its roots in philosophy and which focuses on the lived experience of individuals.

Population
A well-defined group or set that has certain specified properties (e.g. all registered midwives working full-time in Scotland).

Positive correlation
A relationship between two variables where higher values on one variable tend to be associated with higher values on the second variable (e.g. physical activity level and pulse rate).
Positivism
This paradigm assumes that human behaviour is determined by external stimuli and that it is possible to use the principles and

methods traditionally employed by the natural scientist to observe and measure social phenomena.

Qualitative data
Information gathered in narrative (nonnumeric) form (e.g. a transcript of an unstructured interview).

Quantitative data
Information gathered in numeric form.

Quasi-experiment
A type of experimental design where random assignment to groups is not employed for either ethical or practical reasons, but certain methods of control are employed and the independent variable is manipulated.

Randomisation
The random assignment of subjects to experimental and control groups (i.e. the allocation to groups is determined by chance).

Randomised controlled trial (RCT)
In a RCT, participants are randomly assigned either to an intervention group (e.g. a drug treatment) or to a control group (e.g. a placebo treatment). Both groups are followed up over a specified period of time and the effects of the intervention on specific outcomes (dependent variables) defined at the outset are analysed (e.g. serum cholesterol levels, death rates, remission rates).

Random sampling
A process of selecting a sample whereby each member of the population has an equal chance of being included.

Range
A measure of variability indicating the difference between the highest and lowest values in a distribution of scores.
Reliability
Reliability is concerned with the consistency and dependability of a measuring instrument, i.e. it is an indication of the degree to

which it gives the same answers over time, across similar groups and irrespective of who administers it. A reliable measuring instrument will always give the same result on different occasions assuming that what is being measured has not changed during the intervening period.
A number of techniques can be used to ensure the reliability of a standardised measuring instrument such as an attitude questionnaire, personality test or pressure sore risk calculator. These include test-retest, split-half and alternate forms. There are also statistical tests that can be used to assess reliability such as Cronbach Alpha and the Spearman rho correlation coefficient test.

Research methodology
Different approaches to systematic inquiry developed within a particular paradigm with associated epistemological assumptions (e.g. experimental research, grounded theory, ethno-methodology).

Research method
Specific procedures used to gather and analyse research data.

Research question
A clear statement in the form of a question of the specific issue that a researcher wishes to answer in order to address a research problem. A research problem is an issue that lends itself to systematic investigation through research.

Response rate
The proportion (percentage) of those invited to participate in a research study who actually do so.

Sampling
The process of selecting a subgroup of a population to represent the entire population. There are several different types of sampling, including:
Simple random sampling
this probability sampling method gives each eligible element/unit an equal chance of being selected in the sample; random procedures are employed to select a sample using a sampling frame.

Systematic sampling
a probability sampling strategy involving the selection of participants randomly drawn from a population at fixed intervals (e.g. every 20th name from a sampling frame).

Cluster sampling
a probability sampling strategy involving successive sampling of units (or clusters); the units sampled progress from larger ones to smaller ones (e.g. health authority/health board, trust, senior managers).

Convenience sampling (also referred to as accidental sampling) a non-probability sampling strategy that uses the most easily accessible people (or objects) to participate in a study. Purposive/purposeful sampling: a non-probability sampling strategy in which the researcher selects participants who are considered to be typical of the wider population (sometimes referred to as judgmental sampling).

Quota sampling
a non-probability sampling strategy where the researcher identifies the various strata of a population and ensures that all these strata are proportionately represented within the sample to increase its representativeness.

Snowball sampling
a non-probability sampling strategy whereby referrals from earlier participants are used to gather the required number of participants.

Theoretical sampling
the selection of individuals within a naturalistic research study, based on emerging findings as the study progresses to ensure that key issues are adequately represented

Sampling bias
Distortion that occurs when a sample is not representative of the population from which it was drawn.

Sampling error
The fluctuation in the value of a statistic from different samples drawn from the same population.

Sampling frame
A list of the entire population eligible to be included within the specific parameters of a research study. A researcher must have a sampling frame in order to generate a random sample.

Significance level
Established at the outset by a researcher when using statistical analysis to test a hypothesis (e.g. 0.05 level or 0.01 significance level). A significance level of 0.05 indicates the probability that an observed difference or relationship would be found by chance only 5 times out of every 100 (1 out of every 100 for a significance level of 0.01). It indicates the risk of the researcher making a Type I error (i.e. an error that occurs when a researcher rejects the null hypothesis when it is true and concludes that a statistically significant relationship/difference exists when it does not).

Standard deviation
A descriptive statistic used to measure the degree of variability within a set of scores.

Statistic
An estimate of a parameter calculated from a set of data gathered from a sample.

Statistical analysis
Most statistical analysis is based on the principle of gathering data from a sample of individuals and using those data to make inferences about the wider population from which the sample was drawn.

Statistical inference
A procedure using the laws of probability to infer the attributes of a population based on information gathered from a sample.

Statistical significance
A term used to indicate whether the results of an analysis of data drawn from a sample are unlikely to have been cause by chance at a specified level of probability (usually 0.05 or 0.01).

Statistical test
A statistical procedure that allows a researcher to determine the probability that the results obtained from a sample reflect true parameters of the underlying population.

Subjects
A term most often used in positivist research to describe those who participate in research and provide the data.

Survey research
A research approach designed to collect systematically descriptions of existing phenomena in order to describe or explain what is going on; data are obtained through direct questioning of a sample of respondents.

Test-retest reliability
A means of assessing the stability of a research instrument by calculating the correlation between scores obtained on repeated administrations.

Theme
A recurring issue that emerges during the analysis of qualitative data.

Theoretical framework
The conceptual underpinning of a research study which may be based on theory or a specific conceptual model (in which case it may be referred to as the conceptual framework).

Theoretical notes
Notes about the observer's interpretation of observed activities found in field notes.

Theory
In its most general sense a theory describes or explains something. Often it is the answer to 'what', 'when', 'how' or 'why' questions.

Triangulation
This term is used in a research context to describe the use of a variety of data sources or methods to examine a specific phenomenon either simultaneously or sequentially in order to produce a more accurate account of the phenomenon under investigation.

Trustworthiness
a term used to describe whether naturalistic research has been conducted in such a way that it gives the reader confidence in the findings. It can be assessed using the following criteria: Credibility with its connotations of 'truth', credibility can be compared with internal validity in positivist research. A study's credibility is said to be confirmed when the reader recognises the situation described by a research study as closely related to their own experience (sometimes referred to as confirmability).

Dependability
The dependability of a study is evaluated if it meets the associated criterion of auditability. Auditability is achieved when a researcher provides a sufficiently clear account of the research process to allow others to follow the researcher's thinking and conclusions about the data and thus assess whether the findings are dependable.

Transferability
Equivalent to external validity in positivist research (it may also be referred to as applicability). A study is said to be transferable if the findings 'fit' contexts beyond the immediate study situation. In order to transfer the findings elsewhere, readers need sufficient information to be able to assess the extent to which a specific research setting is similar to other settings.

Type I error
An error that occurs when a researcher rejects the null hypothesis when it is true and concludes that a statistically significant relationship/difference exists when it does not.

Type II error
An error that occurs when a researcher accepts the null hypothesis when it is false and concludes that no significant relationship/difference exists when it does.

Validity
In research terms, validity refers to the accuracy and truth of the data and findings that are produced. It refers to the concepts that are being investigated; the people or objects that are being studied; the methods by which data are collected; and the findings that are produced. There are several different types of validity:

Face validity
the extent to which a measuring instrument appears to others to be measuring what it claims to measure.

Content validity
is similar to face validity except that the researcher deliberately targets individuals acknowledged to be experts in the topic area to give their opinions on the validity of the measure.

Criterion-related validity
requires the researcher to identify a relevant criterion or 'gold standard', which is itself reliable and valid, to provide an independent check of the new measure (i.e. to compare the results from a well-established and a new measuring instrument).

Construct validity
refers to the degree to which a research instrument measures a theoretical concept (or construct) under investigation.

Internal validity
refers to the extent to which changes in the dependent variable (the observed effects) can be attributed to the independent variable rather than to extraneous variables.

External validity
refers to the degree to which the results of a study are generalisable beyond the immediate study sample and setting to other samples and settings.

Variable
An attribute or characteristics of a person or an object that takes on different values (i.e. that varies) within the population under investigation (e.g. age, weight, pulse rate).

Variance
A measure of dispersion or variability (spread), calculated by squaring the value of the standard deviation.

Appendix 4

Common errors made in research

Retrieved 9 July 2004 from
http://sociology.camden.rutgers.edu/jfm/errors.html

When we do research, we can make many errors. Some of them occur often enough to have names. Here are nine common ones:

- *Selective observation*
- *Inaccurate observation*
- *Overgeneralization*
- *Made-up information*
- *Ex post facto hypothesizing*
- *Illogical reasoning*
- *Ego involvement in understanding*
-
- *Mystification*

1. **Selective observation**
Selective observation happens when our attention is drawn to answers or observations that confirm our pre-existing beliefs. It's a lot like selective hearing (i.e., when people, especially children, hear only the things they want to hear). For example, if I hypothesize that blacks are more likely than whites to speed, I am probably likely to note the blacks who are speeding while paying less attention to speeding whites and blacks who are not speeding. A better approach to this study would be to write down the speed of every car going by and the race of the driver. I could then make tables and compare the percentages of speeding drivers of each race. Chances are that I'll find that race isn't related to one's likelihood of speeding.

A few ways you can try to avoid selective observation in your research are to do a literature review (so you'll know which relationships other researchers found), decide your research approach beforehand (e.g., when I decided above to write down the speed of every car rather than just depend on my memory), take thorough notes (to prevent biases from affecting your memory), watch for "disconfirmatory" information (such as speeding whites and non-speeding blacks), and consider both "sides" of your study (i.e., try to argue against your hypothesis; if you can't poke holes in your theory then you're more likely to be on the mark).

You could also use time or area sampling. Time or area sampling means that you focus your attention on a smaller part of the action for a given amount of time. Instead of trying to watch the entire crowd at a basketball game, for example, I could look at the rightmost four columns of people for ten minutes, then the next four columns for ten minutes, and so on. By doing this, I would be able to get a picture of what the whole crowd was doing. And, most importantly for selective observation, I would be forced to look at all parts of the crowd at some point in time, rather than just those who were doing what I expected them to do.

2. Inaccurate observation

Inaccurate observation happens when we "misremember" or misrecord data. How many times have you missed a question in an exam because you copied down something incorrectly from the lecture? That's one form of inaccurate observation. You thought you correctly observed the information when you really hadn't done so. Have you ever misunderstood what someone said, and thought s/he said something that rhymed with his/her actual utterances? That's another form of inaccurate observation. Your brain somehow miscoded the information at the processing stage. Inability to remember what you saw is another form. Your brain somehow jumbles or changes the original memory during the recall stage.

If you plan to observe (and possibly even take notes), you can increase your accuracy. Planning includes focusing on the task at hand rather than daydreaming during data collection; this will help prevent many errors. Doing a literature review can help by alerting you to what you might find (that way you won't be as surprised and will be better able to process and recall the information you see or hear). Other techniques include using forms (e.g., where you circle people's characteristics rather than trying to write them down; forms also "guide" your observations to include all the important information points), doing time/area sampling (to reduce the amount and variety of information you are responsible for writing down and remembering at any given moment), and writing down as much information as you can (you should assume that anything you don't write down will be forgotten or remembered incorrectly). Another suggestion is to practise observing and recording your observations before actually doing it for real. Practice will make it easier to quickly and accurately record or summarize a given situation, and will show you the parts of the task about which you are less clear.

3. **Overgeneralization**

Overgeneralization is generalizing to others who are different from one's research population. This happens all the time. A study in New York City finds a high proportion of gang members and school administrators in rural America panic and institute draconian measures intended to stem the proliferation of gangs in their districts. A parenting program works in one community, so planners automatically assume it will work in theirs. A new study program raises grades for high school students, so colleges clamor to include it in their curriculum. All three of these examples illustrate how quickly some people take research findings as absolute. Who knows, maybe the findings actually do generalize. The problem is that you can't make that assumption.

Just because a program works in one community doesn't mean that it will work in another. For example, consider the NCI Alcohol Treatment program in Navajo country. Alcohol abuse programs "borrowed" from dominant society didn't have very high success rates for American Indians, but that didn't stop social service agencies from using them anyway. Then, NCI incorporated traditional practices and ideas (e.g., use of certain ceremonies) into their program which works much better for American Indians. Not ironically, non-Indians (and many Christianized American Indians) don't find the program to be very useful. This example illustrates overgeneralization because the social service agencies assumed that dominant society treatment programs would work equally well for American Indian clients. After all, they worked for whites! The social service agencies were overgeneralizing; that is, they were assuming that what works for whites will work for others. In the end, they learned that what's good for the goose is not always good for the gander. There might be important differences between populations that will affect the success of a given program.

Some ways to avoid overgeneralizing:

- replicate one's study (to ensure that the results apply to different populations),
- support many tests of the same theory (to make sure it operates the same way under different circumstances and with varying populations),
- attempt to use representative samples (to reduce the likelihood of aberrant findings due to the unique sample), and
- recognize the limitations of one's research (possibly the most important; don't claim that your study is the definitive work unless you've paid very close attention to design and implementation).

4. **Made-up information**

Made-up information happens when one fills in details without a scientific basis for doing so. As researchers, we have to fill in a lot of details; this is called inferring. The problem is that some inferring isn't based in science; instead, it's based in stereotype and speculation.

In one of my research classes long ago, a classmate observed and reported to us the following: an attractive young woman was sitting alone in a bar for a few minutes when a man walked in. The two talked briefly, then left together smiling. What happened in that situation? At first, my classmate thought it was a typical "pick up" and may have even been the solicitation of a prostitute (especially since neither consumed any beverages). When he saw this happen day after day at the same time, however, he approached the young woman and asked her to explain what he had been observing. It turned out that she worked in the area, and merely came to sit in the bar to wait for her brother to pick her up after work. Had my classmate just made up the information, he would have assumed a very different situation!

One of my students observed a number of student government meetings and concluded at first that the council was unprofessional and didn't respect each other's views. She based this conclusion on the fact that throughout all the meetings, they were passing notes, especially during discussion of what she felt were important issues. It later turned out that the students were merely following Robert's Rules of Order, and were writing their names on slips of paper to be passed to the student who maintained the speaker's list. He would add the names from the slips of paper onto the bottom of his list and call on them in turn. Oops, major misunderstanding. Had she asked earlier, she would have saved herself a lot of embarrassment! Made-up information may or may not be correct.

For wonderfully humorous examples of this problem, consider Horace Miner's contention that the Nacirema are a "magic-ridden people" who are destined to self-destruct due to their mystical beliefs (take the time to enjoy the article at: http://ernie.bgsu.edu/~jdowell/miner.html), and an unknown scholar's equally clever discussion of the Asu's "overwhelming preoccupation with the care and feeding" of their sacred racs (read the article at: http://ietn.snunit.k12.il/sacred.htm). In case you haven't figured it out, the Nacirema and Asu are 'Americans' (both are simply spelled backwards to baffle the reader) and the writers are poking fun at anthropologists who misinterpret what they see. By far the best example of made-up information is to be found in David Macaulay's Motel of the Mysteries (1979, Boston: Houghton Mifflin Company), a futuristic look at an excavation of the Toot'n'C'mon Motel in the year 4022. Here's a sample of the misunderstandings that the future archaeologists made, this text describing a common credit card found in one of the rooms:

This extremely fine piece of workmanship served as a portable shrine which was to be carried through life and into eternal life. Its delicate inscriptions were intended to identify an individual's religious preference along with the burial site to which the body should be delivered when necessary. Matching inscriptions were found on the main doors of the sanctuary. Because the ancients were unable to predict the exact time of death, each of the shrines had to last for an entire year (p. 64).

Instead of making up information, you could do a variety of things. First, you could do like my classmate above and ask someone who knows what's going on for their opinion. If you're going to be in a strange or new setting, you could do a thorough literature review to help you understand possible outcomes and unique customs (this would have helped my student understand the note passing behavior she observed). Most of all, you should rely on prior research studies and/or theory to guide your own interpretation of what was going on.

5. **Ex post facto hypothesizing**

Ex post facto hypothesizing happens when a researcher decides what happened after it happened and after the study was done. In scientific research, we have to decide what will happen <u>before</u> we do our study, not after. What this means is that our research must be guided by theory, and that we have made predictions (hypotheses) about what we will find. It's similar in some respects to Ex Post Facto laws (laws that have been enacted after the offensive act took place), and are just as repulsive, at least to researchers.

This doesn't mean that one cannot use data that has already been collected by others. Assume, for example, that you wish to research whether election outcomes are based on public perceptions about the economy. You could obtain from a data clearing house, election data from the past. Then, you could somehow assess public perceptions of the economy at the time of each election (through polls from the era, editorials in newspapers, or some other method). You could then correlate the two and test your theory. What differentiates your study from a common case of Ex Post Facto Hypothesizing is that you made your predictions, then tested them. Y• u didn't form your hypothesis before-hand.

The ways to avoid this problem in your own research are simple. First, remember that correlation does NOT imply causation; in other words just because the birth rate is high in areas with lots of storks doesn't mean that the storks are bringing the babies. Then, don't feel obligated to report your research as deductive (that is based on hypothesis testing). If you were simply exploring a topic, own up to it. Exploratory research is very helpful in establishing foundations for future scholars.

6. **Illogical reasoning**

Illogical reasoning is just that: illogical. It ranges from a bit off the mark to absolutely absurd. For example, we have all heard that bread always lands buttered-side down, but seldom question where that knowledge came from. I've actually heard of someone who proposed (rather humorously) that if one took a piece of buttered bread and tied it to the back of a cat and dropped the resulting mass, that the two diametrically opposing forces would cause the bread and cat combo to ceaselessly spin several inches from the floor. It's illogical to assume that the butter side will always land down. I've actually done research that shows that bread (and bagels and crackers and other such things) will land buttered-side up as well (now you know what to do with that horrible dorm toast). Now, the cat is another story; research has repeatedly shown that cats somehow miraculously upright themselves from even rather short falls (just take my word for this; don't try it on the family feline).

We can also make logically flawed assumptions in research. Medical researchers in 1879 argued that masturbation causes insanity and recommended exercise to the point of fatigue as a treatment (Medical and Surgical Reporter, Vol. XLI, 1879, p.542). The same journal contains research that claims that insanity can be contagious if people live together (p.13). In other words, simply masturbating or marrying someone with a history of insanity could make you insane. Despite its lack of logic, this research does add new meaning to Rosenhan's research (1973, Being Sane in Insane Places) that showed that insanity was assumed for anyone who had been admitted to the 12 mental hospitals under study. As a side note, the journal also includes a writeup on coffee as a cure for typhoid fever (p.39). Pretty illogical, eh?

P.S. Just because you reason logically doesn't mean that you're right about what you saw. Think about all the times you've made wonderfully sound assumptions about outcomes and been wrong. We can't all be like Sherlock Holmes and be right every time.

Two ways to avoid illogical reasoning in your own research are to base your decisions on prior research and theory, and to make extensive use of peer review. Peer review is when you have others read and critique your writings; this helps scholars find places where they've reasoned illogically.

7. **Ego involvement in understanding**

Ego involvement in understanding happens when people let the human side of them dictate their findings and how they view findings by other researchers. Those who are members of a researched group (e.g., sorority, family, or religion), for example, may find it difficult to explain what happens without bias; they would feel obligated to protect the "deep, dark secrets" of the group. They may feel compelled to justify even sinister behavior.

Ego involvement can also affect research on a person's "pet project." If I've just spent ten years developing a new treatment program, someone else should do the evaluation because I might be tempted to fudge results here and there, or at least misinterpret things in a way that is favorable to my program. After all, I worked hard on the program; it must really work! Those whose jobs depend on the program should also be excluded from the evaluation team because it would be hard to disband even an ineffective program that provided one's salary.

Sometimes ego involvement affects how we look at and react to research by others. Studies whose findings oppose what we believe are easily dismissed despite their rigor, whereas even shoddy studies that support our viewpoints are cited ad nauseam. Unfortunately, ego involvement by journal editors sometimes determines which studies get into print.

The best way to avoid ego involvement is to try to remain neutral, or to stay away from topics about which you can't be neutral. Be honest with yourself and refrain from research on topics that might be too close to home for you. Another suggestion is to use the team approach. It's harder to get too ego involved when sharing the research task with others who don't have your intense views on a given topic.

8. Premature closure of inquiry

Premature closure of inquiry occurs when we decide that we know enough about a topic and decide that it no longer warrants future study. Some topics are fairly easily dismissed as trite (e.g., science is now certain the earth revolves around the sun). Other topics, however, are still misunderstood (e.g., the causes of crime and insanity). For these less understood topics, it's important to keep researching until we more fully understand them.

Sometimes research is too controversial to get funding or support, regardless of its importance. Studies that parallel those by Stanley Milgram (who did the shocking experiments on obedience to authority) and Philip Zimbardo (whose Stanford prison experiment had to be called off early due to psychological trauma experienced by some of the participants) may have difficulty getting support in today's world. Likewise, medical research like that conducted by notorious Nazi Josef Mengele (whose fascination with flawless research methods led him to literally murder set after set of twins in the name of research) has been condemned by all civilized nations.

The best way to deal with premature closure is to keep looking for answers, even if it involves using different approaches. While the findings of Milgram's and Zimbardo's studies were valuable to society, the toll taken on their subjects was too great. Mengele's methods were simply satanic at best. Contemporary researchers shouldn't quit doing research on medical issues, obedience to authority, and socialization of prison inmates and guards; instead, they should find non-controversial ways to do it. This may require some serious thought and planning. Some contemporary researchers, for example, have studied obedience to authority by having people endlessly tear paper into little squares. Their willingness to comply with this task causes far less stress than the belief that they were administering sometimes fatal shocks to another human being while still allowing us to study the fascinating phenomenon.

9. Mystification

Mystification happens when we attribute results to the supernatural. In olden days (and sometimes to this day), illnesses were blamed on a variety of spirits and deities. Trying to find a cure for cancer might have lead early researchers to see their local clergy! Crime, attributed to the devil's influence, was felt to result from lack of religious training.

Sometimes, the people we study will use mystification. One of my students, for example, asked ranchers about the mutilation of their livestock. To his surprise, a number of them insisted that the damage was caused by space aliens. Rather than report this as the actual cause, he kept looking for more sensible answers.

The ways to avoid mystification are similar to those mentioned above for other errors. First, keep looking for answers when you feel tempted to rely on enchanted explanations. Second, peer review will prevent you from embarrassing yourself when you insist that witches have afflicted young girls in Salem, Massachusetts.

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METHODOLOGY OF BASIC AND APPLIED RESEARCH
(Second Edition)

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REVIEWERS' COMMENTS ON THE FIRST EDITION

Methodology of Basic and Applied Research can be said to have come at an appropriate time. First, it will prove a useful tool for many graduate students seeking insight into what a good thesis and research proposal entail. Second, it will ease the difficult task of writing acceptable academic research papers faced by many young academics. By and large, this book represents a major initiative to tackle the problems and challenges faced by student researchers and junior academics in conducting, managing and reporting research. One would, therefore, recommend this volume to student researchers in Nigerian Universities, and also to both the young and even experienced researchers working in academics, NGOs and other research-oriented establishments. *Prof. Anthony E. Akinlo, Head, Department of Economics, Obafemi Awolowo University, Ile-Ife.*

In all of my teaching and research career spanning over two decades now, this book: ***Methodology of Basic and Applied Research,*** represents the most comprehensive and packaging of this document from the title (6 words), choice of subjects matter and their respective contributors up to, and including, the arrangement of the chapters represents, in themselves a lesson in methodology. The book has, in my view, succeeded most admirably in its aims and objectives. For this, the editors, contributors and the University Management deserve commendations and congratulations. The editorial crew, must, in addition be commended for minimizing the unevenness of quality and style that are inherent or endogenous to compilations of this nature and dimension. Finally, I recommend this **'Road Map'** for conceptualizing, conducting, managing and reporting research findings not just to graduate students or junior academics, but indeed, to ANYBODY in active research. *Prof. Valentine A. Aletor, Dean, School of Postgraduate Studies, Federal University of Technology, Akure.*