INTRODUCTION TO RESEARCH
(A Lecture Note by John I. Ihedioha)

Introduction – What is research?

The word ‘research’ was derived from the French word ‘recherche’ which means ‘to search closely and wisely’ or ‘to go about seeking’. ‘Chercher’ means ‘to search’ and ‘re’ implies a repetition. Literally deriving from its French etymology, research means ‘to study or investigate closely and thoroughly’. The earliest recorded use of the word was in 1577.

Definitions of research – several definitions of research.

i. A systematic and exhaustive search for new knowledge or new interpretation of an existing knowledge.

ii. A formal work undertaken systematically to increase the stock of knowledge and the use of this stock of knowledge to devise new applications.

iii. Any gathering of data, information and facts for the advancement of knowledge.

iv. A process of steps used to collect and analyze information to increase our understanding of a topic or issue.

v. A systematic and objective search for knowledge in order to discover the truth.

vi. A studious inquiry or examination; especially investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws.

Research is used to:

- Establish or confirm facts.
- Re-affirm the results of previous work.
- Solve new or existing problems.
- Support theorems, or develop new theories.
- Expand on past work in a field of study.
- Test the validity of instruments, procedures, or experiments.
The goal of the research process is to produce new knowledge or deepen the understanding of a topic or issue. The primary purposes of all research are therefore: discovery, interpretation, or the development of methods and systems for the advancement of human knowledge and solving of the problems of humanity.

Research is therefore the most important tool for advancing knowledge, for promoting progress and enabling humans to relate more effectively to their environment and fulfill their goals here on earth. It help us to discover the truth about natural phenomenon, and thus in that way enables humans to more efficiently adapt to their environment for a more fulfilling life. The results of research helps us to solve a variety of problems that face humanity today – poverty, disease, climate change etc, and in this way humans are able to improve the quality of their life and living here on earth. Research opens new areas and expands the horizon of knowledge. New theories and beliefs are advanced, and old ones evaluated and retained or discarded based on facts on hand. Research provides information and data needed by policy makers to make vital decisions.

Research is considered an indispensable part of scholarship, which is driven by the consistent existence of many yawning gaps in the existing body of knowledge. In intellectual development, research is categorized as active learning in contrast to passive learning. Passive learning is the common mode of learning which we are all used to, that involves/entails exposure of the learner to facts through lectures, seminars, practical demonstrations and discussion, which is a form of ‘spoon-feeding’. Research, as active learning, entails a systematic inquiry into specific areas of knowledge, location/generation and utilization of information/data, analysis and interpretation of the information located/data generated, and drawing conclusions based on the outcome of the inquiry.

Research is done in all disciplines – there is thus scientific research, artistic research, social research, research in the humanities, economics, business, law, etc. In whichever discipline, research is usually systematic and objective because it follows clearly defined logical procedures in its search for facts or the truth. It is also an objective undertaking because observable, empirical or unbiased methods are adopted in finding solutions to research problems. A researcher utilizes well laid out systematic methods to delve into the unknown to discover or uncover new facts. For it to be called research, a study must be orderly and systematic, and follow known standard steps/methodology in its application. It also has to be critical and exhaustive, with the researcher being willing to faithfully and correctly report the outcome of the search in an acceptable format.
Funding for scientific research comes principally from governments (TETfund Nigeria, Grand Challenges, Canada, National Institutes of Health, USA, Medical Research Council UK, etc), corporate research and development departments (WHO, UNO, FAO, ILRI, IITA), and private foundations/individuals (Bill and Melinda Gates Foundation, Thrasher Research Fund).

**Standard steps in conducting research**

The major steps in conducting research are:

i. Identification of research problem

ii. Literature review.

iii. Specifying the purpose of research.

iv. Determination of specific research questions or hypotheses

v. Data collection

vi. Analyzing and interpreting the data

vii. Reporting and evaluating research

A research starts when a problem that needs to be investigated is identified. The identified problem may be as a result of a lacuna in knowledge available in the area on investigation or due to absence of previous research in the area of investigation. It may also be as a result of previously completed research which was identified to be poorly executed. After the identification of the research problem, the researcher then further refines the problem, sifting out thrash so that the idea becomes clearly investigable – this is more like a process of distillation.

The literature review identifies gaps, flaws or holes in existing body of knowledge or previous research which provides justification for the study. Often, a literature review is conducted in a given subject area before a research question is identified. A gap in the current literature, as identified by a researcher, then engenders a research question. The research question may be parallel to the hypothesis.

The hypothesis is the supposition to be tested. Generally a hypothesis is used to make predictions that can be tested by observing the outcome of an experiment. If the outcome is inconsistent with the hypothesis, then the hypothesis is rejected. However, if the outcome is consistent with the hypothesis, the experiment is said to support the hypothesis. This carefully chosen language is used because researchers
recognize that alternative hypotheses may also be consistent with the observations. In this sense, a hypothesis can never be proven, but rather only supported by surviving rounds of scientific testing and, eventually, becoming widely accepted as true.

The researcher(s) collects data to test the hypothesis. The researcher(s) then analyzes and interprets the data via a variety of statistical methods. The results of the data analysis in confirming or failing to reject the null hypothesis are then reported and evaluated. At the end the researcher may discuss avenues for further research.

Reports of research work exist in form of thesis, dissertations and project reports. Research reports can also be further published in journals, conference proceedings and books. Publishing a research report in a journal or conference proceeding comes under what is known as academic publishing, which is system that enables other academic scholars to peer-review the work, and this makes it available to a wider audience.

Forms, Types and Categories of research and Terms used in Research

Explorative, Constructive and Empirical Forms of Research

These are three forms of research:

i. **Exploratory research** – this helps to identify and define a problem or question.

ii. **Constructive research** – this tests theories and proposes solutions to a problem or question.

iii. **Empirical research** – this tests the feasibility of a solution using empirical evidence; that is, evidence derived from experiment and observation rather than theory.

The boundaries between these forms may not be very clearly defined and in any one research project a combination of one or more of the forms may be applied.

Qualitative and Quantitative Types of Research

**Qualitative research** is a type of research that aims to investigate a question without attempting to quantifiably measure variables or look to potential relationships between variables. In qualitative research, broad questions are asked and data collected are in form of words, images, video etc. Qualitative research is viewed as more restrictive in
testing hypotheses because it can be expensive and time consuming, and typically limited to a single set of research subjects. Qualitative research is often used as a method of exploratory research and as a basis for later quantitative research hypotheses.

**Quantitative research** is the systematic empirical investigation of quantitative properties and phenomena and their relationships. In quantitative research narrow questions are asked and numerical data are collecting and analyzed using statistical methods. Quantitative research designs include experimental, correlation, and survey (or descriptive) studies. Statistics derived from quantitative research can be used to establish the existence of associative or causal relationships between variables.

In either qualitative or quantitative research, the researcher(s) may collect primary or secondary data. Primary data is data collected specifically for the research, such as measurements and outcome of/results generated from interviews or questionnaires. Secondary data is data that already exists, such as census data, which can be re-used for the research.

Researchers choose qualitative or quantitative methods according to the nature of the research topic they want to investigate and the research questions they aim to answer. Most research projects involve both qualitative and quantitative elements, and may utilize both primary and secondary data. It is no more acceptable to do and present results of only qualitative research in scientific investigations.

In summary, the major difference between quantitative and qualitative research is that quantitative research generates numerical data or information that can be converted into numbers, while qualitative research on the other hand generates non-numerical data.

**Basic (Fundamental or Pure) and Applied Research**

**Basic research** also known as *fundamental* or *pure research* is research driven by curiosity, interest and or intuition, which is done to increase understanding of fundamental principles. It is a category of research that advances fundamental knowledge about the world, and is undertaken without hope of attaining practical conclusions directed at any research problem. Basic research strives to refute or support theories that explain how this world operates, what makes things happen, why social relations are a certain way, and why society changes. It generates new ideas, principles and theories, which may not be immediately utilized; though these ideas form
the foundations of modern progress and development in different fields. The outcome of basic research usually furnishes applied researchers with basic baseline information that will help advance their applied problem-solving research efforts. For instance, today’s computers could not exist without the basic research in mathematics conducted more than one hundred years ago, for which there was no known practical application at that time. Basic research is the source of most new scientific ideas and ways of thinking about the world. Generally, basic research is often not intended to yield immediate commercial benefits, rather it is a study done out of curiosity. In the long term however, it forms the basis for applied research and development of many commercial products. Basic research can be exploratory, descriptive, or explanatory; however, it is most commonly explanatory research.

**Applied research** is a form of systematic inquiry involving the practical application of science. It accesses and uses some part of the research communities’ accumulated theories, knowledge, methods, and techniques, for a specific, often state-, business-, or client-driven purpose. It thus makes use of basic information provided by basic researchers to systematically inquire over research problems that has direct import and that will lead to specific practical conclusions that will solve problems. Applied research therefore deals with solving practical problems and generally employs empirical (experimental or observation-based) methodologies.

**Original research**

**Original research** is research done to produce new knowledge, rather than to present the existing knowledge in a new form (*e.g.*, summarized or classified). In contrast to a review, it is a research that is not exclusively based on a summary, review or synthesis of earlier publications on the subject of research. The material produced in original research is of a primary source character.

There are different forms of original research, depending on the discipline it pertains to. In experimental work, original research typically involves direct or indirect observation of the researched subject or objects in the laboratory or in the field, documentation of the methodology, results, and conclusions of the experiment or set of experiments, and offering of a novel interpretation of previous results. In analytical work, original research leads to production of some new (for example) mathematical results, or a new way of approaching an existing problem. In some disciplines that do not typically carry out experimentation or analysis of this kind, the originality of a research is in the particular way existing understanding is changed or re-interpreted based on the outcome of the
work of the researcher. Postgraduate students are commonly required to undertake original research as part of a thesis, dissertation or project report.

**Empirical research**

*Empirical research* is a way of gaining knowledge by means of direct and indirect observation or experience. This record of one's direct observations or experiences, which is known as empirical evidence, can be analyzed quantitatively or qualitatively. Through quantifying the evidence or making sense of it in qualitative form, a researcher can answer empirical questions, which should be clearly defined and answerable with the evidence (data) collected. Many researchers combine qualitative and quantitative forms of analysis to better answer research questions.

The use of the term empirical is related to the philosophical theory of empiricism, which is based on the principle that knowledge arises from experience and evidence gathered specifically using the senses. In scientific use, however, the term empirical refers to the gathering of data using only evidence that is observable by the senses or in some cases using calibrated scientific instruments.

In empirical research, the researcher attempts to describe accurately the interaction between the instrument (or the human senses) and the entity being observed. If instrumentation is involved, the researcher is expected to calibrate his/her instrument by applying it to known standard objects and documenting the results before applying it to unknown objects. In practice, the accumulation of evidence for or against any particular theory involves planned research designs for the collection of empirical data.

Accurate analysis of data using standardized statistical methods in scientific studies is critical to determining the validity of empirical research. Statistics such as regression, correlation, t-test, chi square, and various types of analyses of variance (ANOVA) are usually used to arrive at logical and valid conclusions. If empirical data reach significance under the appropriate statistical formula, the research hypothesis is supported. If not, the null hypothesis is supported (or, more correctly, not rejected), meaning no effect of the independent variable(s) was observed on the dependent variable(s). It should be noted that outcome of empirical research using statistical hypothesis testing is never proof. It can only support a hypothesis, reject it, or do neither. The methods yield only probabilities.

In scientific research, *empirical evidence* refers to objective evidence that appears the same regardless of the observer. For example, a digital thermometer will not display
different temperatures for each individual who observes it. Temperature, as measured by an accurate, well calibrated digital thermometer, is empirical evidence. In contrast, non-empirical evidence is subjective, depending on the observer. Using an example related to the former, an observer (A) might truthfully report that a room is warm, while another observer (B) may truthfully report that the same room is cool, though the thermometer reading of this same room remained same/constant. The strength of the use of empirical evidence is that it negates this effect of personal (i.e., subjective) experience.

Normative Research and the Scientific Method

Normative research and the Scientific method are two major methods of research. **Normative research** is usually based entirely on the impressionistic observations of the investigator, i.e. based on the impression rather than on facts or reasoning. The normative researcher begins his or her study with a stated possible conclusion after which he goes on to scant for possible evidence to support the conclusion.

**The scientific method** is a body of techniques for investigating phenomena, acquiring new knowledge, or correcting and integrating previous knowledge, which is based on empirical and measurable evidence subject to specific principles of reasoning. The scientific method commonly involves systematic observation, measurement, and experiment, and the formulation, testing, and modification of hypotheses. The major characteristic which distinguishes the scientific method from other methods of acquiring knowledge is that the scientific method seeks to let reality speak for itself, supporting a theory when a theory’s predictions are confirmed and challenging a theory when its predictions prove false. The scientific method thus utilizes systematic investigation to establish causal relationships between the issue being investigated, and these relationships are tested using appropriate standard methods before conclusions are reached.

The scientific method is considered the most reliable approach to research. The term scientific method does not imply that this method is specifically used in the sciences. No. Rather it is applicable in other areas such as the arts, humanities etc., though it originated from the sciences. The scientific method is termed so because it is a systematic and well-ordered method of research in which the research question is stated, relevant data is collected, analyzed and tested with appropriate tools and pertinent conclusions are arrived at based on the evidence available from the results of analysis.
Although scientific method procedures vary from one field of inquiry to another, identifiable features distinguish scientific method from other methods of obtaining knowledge. Scientific researchers propose hypotheses as explanations of phenomena, and design experimental studies to test these hypotheses via predictions which can be derived from them. These steps must be repeatable, to guard against mistake or confusion in any particular experimenter. Scientific inquiry is generally intended to be as objective as possible in order to reduce biased interpretations of results. Another basic expectation in scientific method is to document, archive and share all data and methodology so that they are available for careful scrutiny by other scientists, giving them the opportunity to verify results by attempting to reproduce them. This practice, called full disclosure, also allows statistical measures of the reliability of these data to be established (when data is sampled or compared to chance).

The scientific method generally involves making conjectures (hypothesis), deriving predictions from them as logical consequences, and then conducting experiments based on these predictions to determine whether the original conjecture was correct.

The major steps involved in the scientific method of inquiry are:

i. Identify the issue(s)/event(s) to be investigated and define a research question.

ii. Gather information and resources (observe) on the issue(s)/event(s).

iii. Develop or form an explanatory hypothesis.

iv. Test the hypothesis by performing an experiment and collecting data in a reproducible manner.

v. Analyze the data.

vi. Interpret the data and draw conclusions.

vii. Publish results.

viii. Retest (frequently done by other scientists)

**Hypothesis**

A hypothesis is simply defined as a testable prediction which designates the relationship between two or more variables. A hypothesis is a conjecture about some population that may explain the observed behavior, which is based on the knowledge obtained while identifying the issues/events to be studied and formulating the research question. A hypothesis may be derived from our daily observations, earlier
research/studies in the area or from theories. The hypothesis might be very specific, or broad. The conjecture might be that a new drug will cure a specific disease or that an agent or microbe causes a disease.

Terms commonly associated with statistical hypotheses are null hypothesis and alternative hypothesis. A **null hypothesis** is the conjecture that the statistical hypothesis is false, e.g., that the new drug does nothing (lead to no significant cure) and that any cures are due to chance effects. Researchers normally want to show that the null hypothesis is false. The **alternative hypothesis** is the desired outcome, e.g., that the drug does better than chance.

Generally a hypothesis is used to make predictions that can be tested by observing the outcome of an experiment. A hypothesis cannot be proven. If the outcome of the experiment is inconsistent with the hypothesis, then the **hypothesis is rejected**. However, if the outcome is consistent with the hypothesis, the experiment is said to **support the hypothesis**. These words are carefully chosen because researchers recognize that alternative hypotheses may also be consistent with the observations. In this sense, a hypothesis can never be proven, but rather only supported by surviving rounds of scientific testing and, eventually, becoming widely thought of as true.

### Qualities of a good researcher

A good researcher must be a:

- Curious person (curiosity).
- Voracious reader.
- Skeptic – ‘he must doubt whatever he reads and read whatever he doubts’. It is this doubt that causes him/her to attempt to establish the veracity of a statement or proposition or debunk its authenticity.

A good researcher should know how to:

- Think logically.
- Organize effectively.
- Discriminate between useful and useless information.
- Document properly.