# Research Methodology (RM –A)

Paper I

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# Syllabus

- Foundations of Research: What is Research? Objectives of Research, Scientific Research, Research and Theory, Conceptual and Theoretical Models, Importance of research methodology in scientific research, Types and Methods of Research
- Planning of Research: Selection of a Problem for Research, Formulation of the Selected Problems, Hypothesis formation, Measurements, Research Design/Plan.

# Learning Objective

- Students will know why scientific research is undertaken
- Students should be able to identify the overall process of designing a research study from its inception to its report
- Students should know the primary characteristics of different types of research
- Students should be able to identify a research problem stated in a study.

# Difference between Search and Research

- **Search**: Non scientific means and random process of looking for something- information
  - Google Search, Literature Search, PubMed
- **Research**: Systematic foundation through which

➢new knowledge is attained,

➢existing knowledge is improved,

➢new techniques and processes are developed.

Research is important for the advancement of any field

- What's your understanding of Research ?

# What is Research ?

**“Research is seeing what everybody else has seen and thinking what nobody else has thought.”**

- *Albert Szent-Györgyi*

Szent-Györgyi (1893-1986) was a Hungarian pharmacologist known for his work on vitamins and oxidation. He was awarded the Nobel Prize in Physiology or Medicine in 1937.

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- **“Research is something that everyone can do, and everyone ought to do. It is simply collecting information and thinking systematically about it.”**

- *Raewyn Connell*

Connell is an Australian sociologist. She is a former professor of at the University of Sydney and is known for her work on gender and transgender studies.

- **"Research is creating new knowledge.“**

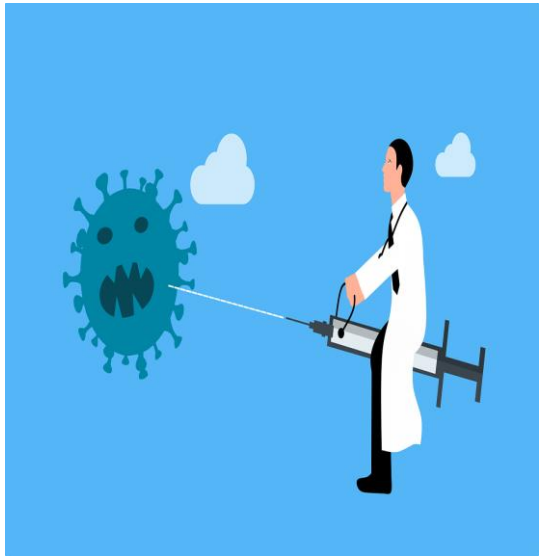
*- Neil Armstrong*

Armstrong (1930-2012) was an American astronaut famed for being the first man to walk on the Moon.

- **"I believe in innovation and that the way you get innovation is you fund research and you learn the basic facts."**

*- Bill Gates*

Gates needs little introduction – he’s an entrepreneur, philanthropist and the founder of Microsoft.



- **“If we knew what we were doing, it would not be called research, would it?”**

*- Albert Einstein*

- Maybe the most famous scientist of all time, Albert Einstein (1879-1955) was a German physicist who came up with the theory of relativity. However, it was his description of the photoelectric effect, the interplay between light and electrically charged atoms, that won him the Nobel Prize for Physics in 1921.

# Foundation of Research- Oxford dictionary

- *noun*
- the systematic investigation into and study of materials and sources in order to establish facts and reach new conclusions.

- *verb*
- investigate systematically.

# WHO Research Methodology 1992

- Research is a quest for knowledge through diligent observation, comparison, investigation or experimentation aimed at discovery and interpretation of new knowledge
- Existing knowledge is improved, new / novel techniques and processes are developed.


- Research is art of scientific investigation
- Scientific and systematic search for pertinent information on a specific topic is **Research** and the methods adopted as known as **RESEARCH METHODOLOGY**

# Scientific Research


- Research conducted for the purpose of contributing towards science by the *systematic collection, interpretation and evaluation of data* in a planned manner is called **scientific research**

- Scientific and systematic search for pertinent information on a specific topic
- A researcher is the one who conducts this research

# Characteristics of Research

1. A *systematic approach* must be followed for accurate data. Rules and procedures are an integral part of the process that set the objective. Researchers need to practice ethics and a code of conduct while making observations or drawing conclusions.

2. Research is based on *logical reasoning* and involves both inductive and deductive methods.

3. The data or knowledge that is derived is in real time from *actual observations* in natural settings.

4. There is an *in-depth analysis* of all data collected so that there are no anomalies associated with it.

5. Research creates a path for *generating new questions*. Existing data helps create more opportunities for research.

6. It makes use of all the available data so that there is *no ambiguity in inference*.

7. *Accuracy* is one of the most important aspects of research. The information that is obtained should be accurate and true to its nature. For example, laboratories provide a controlled environment to collect data. Accuracy is measured in the instruments used, the calibrations of instruments or tools, and the final result of the experiment.

# Motivations in Research

- The factors that motivate people to undertake research are

1. Desire to get a research degree along with its consequential benefits
2. Desire to face the challenge in solving the unsolved problems
3. Desire to get intellectual joy of doing some creative work
4. Desire to be of service to society
5. Desire to earn respect
6. Desire to get better employment
7. Curiosity about new things

- Whats your motivation for research ?

What is your Intention?

# OBJECTIVES OF RESEARCH

**The purpose of research is to discover answers to questions through the application of scientific procedures.**

**The main aim of research is to find out the truth which is hidden and which has not been discovered as yet.**

**Though each research study has its own specific purpose, research objectives may fall into a number of following broad groupings:**

**1. To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulative research studies);**

**2. To portray accurately the characteristics of a particular individual, situation or a group (studies with this object in view are known as descriptive research studies);**

**3. To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies);**

**4. To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies).**

# Research Topic

- Broad subject matter being investigated in a study. May include many research problems to be delineated
  - Focuses study to a defined manageable level
  - Provides structure to steps in scientific methods
  - Include
    - *Research Problem/ Gap*
    - *Research Question*
    - *Research Need*

# Research Problem/ Gap

- Area or condition that is unsatisfactory, needs improvement, requires new answers/ contradiction/ conflicting theory, insufficient studies or research papers (eg, geographical, people (low income/high income, gender)
  - Helps define clearly the research topic so that dedicated and focussed efforts area made on relevant areas
  - Research Problem has a purpose-focus and specific
  - Provides a situation/ circumstance that requires a solution to be described, invented, explained or predicted
  - Not all problems are researchable – need empirical investigation, value based concerns

# Sources of Research Problem

- Theories
  - Previous Work
  - Confirm or contradiction

- Personal Experience
- Replication- new twist on previous study
- Clarification a Understanding

# Research Question

- Refined statement of specific components of the research problem
- Components of research problem may have to be broken down into relevant research questions
- Research question guides what kind of data is required to address the research problem
- Worded in present tense and comprising one or more variables
  - Closed Ended Questions- answered by FACTS
  - Open Ended Questions are good Research Questions- Require FACT and INTERPRETATION

# Examples of Research Question

- Industrial Research :Designing processes for mass/ bulk manufacture of chemicals- petroleum refining, petrochemicals- polymers, food drug ?
- Developing a catalyst for efficient and green synthesis/manufacturing of value added chemical X ?

- The characteristics of good RQ are expressed by acronym “FINERMAPS” expanded as

- feasible
- interesting
- novel,
- ethical,
- relevant,
- manageable,
- appropriate,
- potential value,
- publishability, and
- systematic.


- Reference: Hulley SB, Cummings SR. Conceiving the research question. In: Hulley SB, Cummings SR, Browner WS, Grady D, Hearst N, Newman TB, editors. *Designing Clinical Research.* Baltimore: Williams & Wilkins; 2007. pp. 17–25

# Developing an Effective Research Question

- Begin by identifying a broader subject of interest that lends itself to investigate, for example, hormone levels among hypospadias
- Do preliminary research on the general topic to find out what research has already been done and what literature already exists.[7] Therefore, one should begin with “information gaps” (What do you already know about the problem? For example, studies with results on testosterone levels among hypospadias
- What do you still need to know? (e.g., levels of other reproductive hormones among hypospadias)
- What are the implied questions: The need to know about a problem will lead to few implied questions. Each general question should lead to more specific questions (e.g., how hormone levels differ among isolated hypospadias with respect to that in normal population)
- Narrow the scope and focus of research (e.g., assessment of reproductive hormone levels among isolated hypospadias and hypospadias those with associated anomalies)
- Once question has been framed, one should evaluate it. This is to realize if these would be effective RQs or if they need more revising

# Research methodology

- Research methodology is a way to systematically solve the research problem.
- Includes the research methods and the logic behind the methods used
- Has to be decided in the context of our research study and explain why we are using a particular method or technique and why we are not using others so that research results are capable of being evaluated either by the researcher himself or by others

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# Research Methods as opportunity and challenge

- Methods can enable but also limit evidence
- All methods are valuable but have weaknesses/ limitations
- Offset weakness by using different/ multiple methods
- Choose research methods that compliment strengths of one with weakness of the other.
- Empirical (coming from experience) knowledge requires consistency or convergence of evidence across studies from multiple methods

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# Research Process

Research process consists of series of actions or steps necessary to effectively carry out research and the desired sequencing of these steps.

The various steps involved in a research process are not mutually exclusive; nor they are separate and distinct.

They do not necessarily follow each other in any specific order.

However, the following order concerning various steps provides a useful procedural guideline

regarding the research process:

1. Formulating the research problem
2. Extensive literature survey
3. Development of working hypotheses
4. Preparing the research design
5. Determining sample design
6. Collecting the data
7. Execution of the project
8. Analysis of data
9. Hypothesis-testing
10. Generalizations and interpretation
11. Preparation of the report or the thesis

# Research and Theory (Chicken egg riddle)

➢ **Theory:**

- Abstract system of concepts and their relationships that help understanding a phenomenon
- Generalized thinking or conclusion which is result of analysis that is scientifically proven with evidence- guides research and organizes ideas
- Conceptual frameworks with no practical aspect to them. Used to explain things
- Result of research based on a hypothesis
- Always tentative, never proven- gives rise to new research

➢ **Research**:

- Way of expanding existing knowledge and creating new knowledge performed scientifically and systematically.
- Practical aspect to research
- Research is preceded by a hypothesis
- If hypothesis is true, it may become a theory
- Research precedes theory. Based on research, theory is made
- Medical research separated from theory when applied research is considered

# Theory

- Purpose:
  - Prediction
  - Understanding

- Levels of Theory
  - Abstract Level-based on general ideas beyond what we observe physically
  - Empirical Level- based on observation and measurement of phenomenon, as directly experienced by researcher

- Process of Theory Development
  - Induction – aims at developing theory starts observations, seek patterns and make generalization that form the basis of theory
  - Deduction- based on inference made by an observation/ existing knowledge, affirms with observation and arrives at confirmation

# Example

- Deductive reasoning for Theory Development:  aimed at testing a theory based on causality
  - Describes how population changes over time by adapting to environmental challenges
  - Newton's Laws of Motion based on unobservables like inertia and gravitation
  - Starts exploratory  with general idea--------hypothesis--------observations and test it to our original idea
  - Top Down Approach

- Inductive reasoning for Theory Development (gather data---- look for patterns------ develop hypothesis---------theory
  - All cells arise from pre-existing cells
  - Boyle's Law derived from observables
  - Bottom Up approach : start with specific measurements--
  - Base new theory on data rather than previous assumptions

# Types of Theory in Research

- Grounded Theory:
  - Sets to develop theory from data obtained systematically (iteratively and dynamically) from comparative  analysis
  - Based on inductive
  - Used both in qualitative and quantitative research

- Axiomatic theory:
  - Used in mathematics and logic
  - Starts with axioms (statement taken to be true, as starting point for further reasoning)

# Task- Pair and Share

- Formulate a research question
- Think of sub questions
- Make a list of answers/ explanations for your questions
- List of factors influencing your response
- Share with partner
- Partner – critique where assumptions in the response
- Do you need to address assumptions before addressing research question?

# Reading Material

- Read more: Difference Between Search and Research | Difference Between http://www.differencebetween.net/language/difference-between-search-and-research/#ixzz7CgXDhdSz
- Wikipedia
- Open Educational Resources (OER commons)