**Lesson 02: Characteristics of Scientific Research**

**Introduction :**

The scientific method is a systematic approach used by scientists and researchers to study and understand the natural world. It involves a series of steps and principles that help ensure the reliability and validity of scientific investigations.[[1]](#footnote-2)

**1-Important Characteristics of Scientific Research:**

* Aim
* Rigor
* Testability
* Reliability
* Accuracy and Confidence
* Objectivity
* Generalizability
* Thrift (cost-effective )

**Characteristics of Scientific Research – Aim:**

* The aim/purpose of scientific research must be written clearly for example:
	+ to increase the performance of a gas sensor?
	+ to reduce the interaction between iron and oxygen?
	+ to characterize the optical properties of glass?

**Characteristics of Scientific Research – Rigor:**

* Based on a good theoretical base and sound methodology
* Careful /or Scrupulous:
	+ e.g. all design parameters concerning the gain in transformer power **must be** considered; geometrical length, temperature, input signal power and wavelength.
	+ e.g. stability of current source for the pump laser system.

**Characteristics of Scientific Research-Testability:**

1. Test theoretical model by **Simulation or Experiment.**

 2. Analysis of performance parameters against the design parameters.

* + e. g. Diode theoretical model shows low current with low input signal power.
	+ Experiment to test this relationship while other design parameters are fixed can be carried out.
	+ Gain is measured against input signal power.

**Characteristics of Scientific Research – Reliability:**

* The same relationship achieves repeatedly under the same design parameters.
* e.g. linear current-voltage relationship for electrical resistivity of copper rods of different sizes. [[2]](#footnote-3)

**Characteristics of Scientific Research - Accuracy & Confidence:**

* **Accuracy** refers to the closeness of the findings to reality ( e.g. g = 9.8 m/s2)
* **Confidence** refers to the probability that our estimations are correct.

**Characteristics of Scientific Research – Objectivity:**

Conclusions drawn from the analysis of data must be objective. It is proved from development of data and **Supported by the theoretical model.
Characteristics of Scientific Research – Generalizability:**

Scope of applicability:

* The wider, and better in the applicability,For example (e. g.) Rate Equation Model applicable for lasers and fibre amplifiers systems.

**Characteristics of Scientific Research – Thrift (cost-effective ):**

1. The Fact is straight-forward.
2. Simplicity in explaining the phenomena or problem.
3. Assumptions are critical.
4. Minimize the dependent variables . [[3]](#footnote-4)

**High Quality Research:**

* It is based on the work of others.
* It can be replicated (duplicated).
* It is generalizable to other settings.
* It is based on some logical rationale and tied to theory.
* It is achievable!
* It generates new questions or is cyclical in nature.
* It is an apolitical activity that should be undertaken for the improvement of society.

So, the characteristics of research are:

* + Systematic- All steps must be inter related- one to another
	+ Logical- Agreeing with the principles of logic
	+ Empirical-Conclusions should be based on evidences/observations
	+ Objectivity- It must answer the research questions
	+ Replicable- reproducible
	+ Transmittable
	+ Quality control- Accurate measurements
	+ All well designed and conducted research has potential application. [[4]](#footnote-5)

**02-What is Bad Research?**

* The opposites of what has been discussed.
* Looking for something when it simply is not to be found.
* Plagiarizing other people’s work.
* Falsifying data to prove a point.
* Misrepresenting information and misleading participants

**03-What Isn’t Research?**

* Playing with technology (neglecting fundamentals)
* Book report.
* Programming project.
* Doing what others have already done.

 However, some of these points can be done as part of a research.[[5]](#footnote-6)

**04-Why do research?**

* Desire to get a research degree along with its consequential benefits
* Desire to face the challenge in solving the unsolved problems
* Desire to get intellectual joy of doing some creative work
* Desire to be of service to society
* Desire to get respectability
* Directives of government, employment conditions etc.
* Validate intuition
* Improve methods
* Demands of the Job
* For publication/patent.[[6]](#footnote-7)
* Research provides you with the knowledge and skills needed for the fast-paced decision-making environment.[[7]](#footnote-8)

5-**Purpose of scientific research:**

Scientific research has several uses and purposes. It is used in the scientific community to advance knowledge about a variety of scientific areas. It is used in the medical field to discover and refine different types of medical treatments and interventions. Mental health professionals use it to diagnose, treat, and prevent various types of mental health problems (e.g., depression, anxiety). Nutritionists use scientific research as the basis for dietary plans and general health coaching. Educators use it to create educational and vocational training programs as well as identify the best teaching practices. In fact, a lot of what is taught in schools is the result of scientific discovery through scientific research.

**6-Importance of scientific research**

Scientific research is important and provides many benefits. It is a way to expand the general knowledge of societies. It helps people devise solutions to a variety of real-world problems. And it helps makes life easier through technological innovations. [[8]](#footnote-9)

The reasons why it is important for research to be scientific are:

It leads to the **progression of our understanding of a phenomenon.** Based on these findings, researchers can outline the motivations/drives concerning individuals' thoughts and behaviours. They can also discover how illnesses occur and progress or how to treat them.

Since research is used, for example, to test the effectiveness of a treatment, it is crucial to ensure that it is based on scientific and empirical data. This ensures that people get the correct treatment to improve their condition.

Scientific research ensures that the findings collected are **reliable** and **valid.** Reliability and validity are essential because they guarantee that the results apply to the target population and that the investigation measures what it intends.

This process is what causes the progression of knowledge in the scientific fields. [[9]](#footnote-10)

**7-Motivation in research:**

What makes people to undertake research? This is a question of fundamental importance. The possible motives for doing research may be either one or more of the following:

- Desire to get a research degree along with its consequential benefits;

- Desire to face the challenge in solving the unsolved problems, i.e., concern over practical problems initiates research;

- Desire to get intellectual joy of doing some creative work;

- Desire to be of service to society;

- Desire to get respectability.

However, this is not an exhaustive list of factors motivating people to undertake research studies. Many more factors such as directives of government, employment conditions, curiosity about new things, desire to understand causal relationships, social thinking and awakening, and the like may as well motivate (or at times compel) people to perform research operations. [[10]](#footnote-11)

**8- Research’s qualities:**

Research may have certain other qualities such as:

**a)** It is a prearranged / structured enquiry (a formal step by step method or sequence to take up research activity is developed to ensure correctness of data and validity of processes). Scientific methods consist of systematic observation, classification and interpretation of data. The degree of formality, rigorousness, verifiability and general validity of scientific methods establish the results obtained.

**b)** It utilizes acceptable scientific methodology to solve problems (the method used should be able to give repetitive results under similar conditions).

**c)** It should create new knowledge that is generally applicable. (The outcomes should be such that they are not specific to particular issue or a situation but need to be generalized for application to comparable issues).

**d)** It is creative process to develop better understanding of mankind, social and cultural and economical issues.

**e)** It should be useful to others who wish to apply the findings in developing new policies or applications of findings of a research in the benefit of public.

**How to ensure a good quality Research?**

* Purpose should be clearly defined.
* Common concepts should be used that can be understood by all.
* Research procedures should be explained in detail.
* Research design should be carefully planned.
* Researcher should declare all the possible errors and their possible impact on findings.
* Analysis of data should be sufficiently adequate to reveal significance.
* The methods of analysis should be appropriate.
* The validity and reliability of the data should be checked carefully.
* The researcher should good command over research methodologies and should be intelligent and experienced.
* Ethics in research refers to a code of conduct of behavior while conducting research. Ethical conduct applies to the organization and the members that sponsor the research, the researchers who undertake the research, and the respondents who provide them with the necessary data.[[11]](#footnote-12)

**9-Features of Good Research :**

- Originates with a question or problem

- Requires clear articulation of a goal

-Follows a specific plan or procedure

-Often divides main problem into sub problems

- Guided by specific hypothesis

- Accepts certain critical assumptions

- Requires collection and interpretation of data

- Systematic and Logical

- Empirical and Replicable . [[12]](#footnote-13)

**Conclusion:**

Scientific research has many characteristics, and is subject to methodological and scientific principles that the researcher must respect, the most important of which are objectivity, seriousness, and commitment to the basic theories in the specialty.

1. https://makemeanalyst.com/characteristics-of-scientific-method [↑](#footnote-ref-2)
2. Thomas Varghese: **INTRODUCTION TO RESEARCH METHODOLOGY**, Dept. of Physics

Nirmala College, Muvattupuzha, 3 October 2023 [↑](#footnote-ref-3)
3. ibid [↑](#footnote-ref-4)
4. ibid [↑](#footnote-ref-5)
5. Khaldoon Naji Abbas**:INTRODUCTION TO RESEARCH METHODOLOGY**, Mustansiriyah University , F. S 2022-2021

 [↑](#footnote-ref-6)
6. Thomas Varghese: **INTRODUCTION TO RESEARCH METHODOLOGY, op , cité** [↑](#footnote-ref-7)
7. Donald R. Cooper :**INTRODUCTION TO BUSINESS RESEARCH** , p02

 [↑](#footnote-ref-8)
8. Travis Hartin: **What is meaning of scientific research?** https://study.com/academy/lesson/what-is-scientific-research.html [↑](#footnote-ref-9)
9. https://www.hellovaia.com/explanations/psychology/research-methods-in-psychology/scientific-research/
 [↑](#footnote-ref-10)
10. C.R. Kothari: **Research Methodology Methods and Techniques**, New Age International (P) Limited Publishers , 02 edition, 2004, P02 [↑](#footnote-ref-11)
11. **RESEARCH: MEANING, TYPES, SCOPE AND SIGNIFICANCE ,** Uttarakhand Open University 1 P04 , 05 [↑](#footnote-ref-12)
12. Pushpalata Trimukhe: **Research mEthodoLogy.**  [↑](#footnote-ref-13)