

Message of the Day

Every morning,

when we wake up, we have twenty-four brand-new hours to live. *What a precious gift!*

We have the capacity to live in a way that these twenty-four hours will *bring Peace, Joy and Happiness* to ourselves and others.

—Thich Nhat Hanh

photo by Krapp-03



Engineering Research & Development Methodology

Basics of Research

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Basics of Research

- **Research**
- **Scientific Knowledge**
- **Characteristics of Scientific Research**
- **Types of Research**
- **Reflective Thinking**



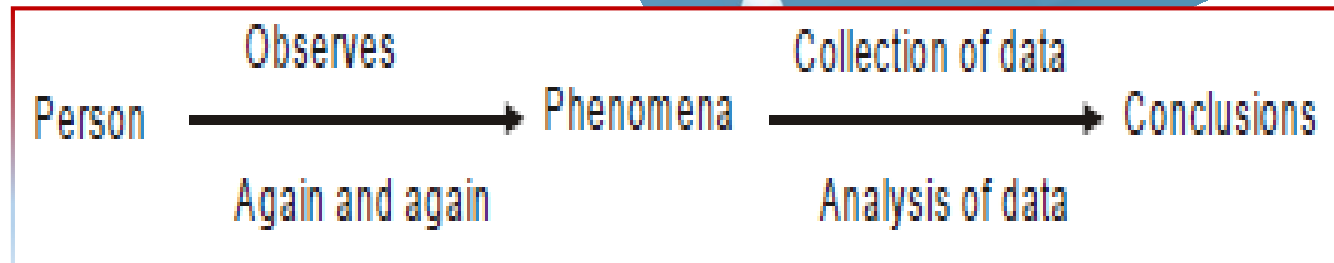
Research

Research

■ The term 'Research' consists of two words:

- Research= **Re** + **Search**
- Re means again & again
- Search means to find out something

■ The process is :



- Research is a process of which a person observes the phenomena again & again, collects data & on the basis of data draws some conclusions.

Research

■ Research – definitions

- a scientific & systematic **search** for pertinent information on a specific topic.
- “a careful **investigation** or **inquiry** especially through search for new facts in any branch of knowledge.”(*The Advanced Learner’s Dictionary of Current English*)
- a “systematized effort to **gain new knowledge.**”
- considered as a **movement from the known to the unknown.**
- considered an activity which aims to make an **original** contribution to knowledge.



Research

- Originality in research indicates:
 - doing something that has not been done before.
- You can be original in two ways:
 - 1) in **the way you do things**
 - Example: doing something someone has done before but using a different technique or approach.
 - 2) by producing or developing something that has not been produced before.
- Thus, original outcomes might include a new product, a new theory, a new model or method.



Research

■ Significance of Research

- Research promotes the development of **logical habits of thinking & organization**.
- Research provides **guidelines** for solving different problems.
- It is a sort of **formal training** which enables one to understand the new developments in one's field in a better way.



Research

■ Significance of Research

- To students who are doing research,
 - **careerism** or a way to attain a high position in the social structure;
- To professionals in research methodology,
 - a source of **livelihood**;
- To philosophers & thinkers,
 - the outlet for **new ideas** & **insights**;
- To literary people,
 - the development **of new styles** & **creative work**;
- To analysts & intellectuals,
 - the generalizations **of new theories**.



Research

■ Purpose of Research

- Though each research has its own specific purpose, generally its purpose include:
 - to discover answers to questions through the application of scientific procedures
 - to find out the truth which is hidden & which has not been discovered yet
 - to solve a problem
 - to predict , plan & control
 - to test or disprove a theory
 - to come up with a better way



Research

- **Why We Do Research?** This can also be a purpose
 - **Description**—A goal of science in which behaviors are systematically & accurately *characterized*.
 - **Explanation**—A goal of science in which a researcher achieves *awareness* of why behaviors occur as they do.
 - **Prediction**—A goal of science in which a researcher can *specify in advance* those situations in which a particular behavior will occur.
 - **Control**—A goal of science in which a researcher can *manipulate variables* in order to produce specific behaviors.





Scientific Knowledge

Scientific Knowledge

- There are different paths to factual knowledge in our lives.
- We will see that not all roads to knowledge are equally useful.
- The American philosopher Charles Sanders Peirce (1877) identified several ways of knowing,
 - **tenacity, authority, the a priori method, & the scientific approach.**
- He concluded that the best approach was the scientific one.



Scientific Knowledge

■ Tenacity

- the mode of accepting knowledge because one is **comfortable with it** & simply wants to hold onto it
- involves **simply believing something** because, based on your view of the world & your assumptions, **you don't want to give up your belief**
- People do this all the time; you have probably discovered that it can be difficult to convince people to change their minds.
- However, *if two people hold mutually contradictory beliefs, both cannot be true.*



Scientific Knowledge

■ Authority

- The mode of accepting knowledge because **a person in a position of authority claims that something is true or valid.**
- This approach removes the burden from any single person to make decisions; instead, one would **rely on an expert** of some kind.
- Peirce talked about authorities who would force beliefs under threat of some kind of penalty, but we can generalize to any acceptance of knowledge because **somebody whom we trust says something is true.**



Scientific Knowledge

■ A priori method

- The mode of accepting knowledge based on **a premise that people have agreed on, followed by reasoned argument.**
- As Peirce noted, though, experts with different perspectives will hold different beliefs. How is one to know which expert is actually right?
- He then suggested that people might fix their knowledge based on **consensus & reasoned argument**, the *a priori approach*.
- The problem here, he wrote, was that reasons for believing something may change over time, so what was seen as true in the past may change.



Scientific Knowledge

■ Scientific approach

- The mode of accepting knowledge based on **empirically derived data**.
- to know universal truths, he reasoned, the **most valid approach** is through science, which is objective & self-correcting.
 - Gradually, we can accumulate knowledge that is valid & discard ideas that prove to be wrong.
- One of the major differences between scientific knowledge & other kinds of knowledge is that scientific work is much **more systematic** than casual observation.
 - scientific knowledge relies on the fact that our observations are objective, data-driven, public, & potentially replicable.



Characteristics of Scientific Research

Characteristics of Scientific Research

■ Scientific research is public

- Scientific research information must be **freely communicated** from one researcher to another.
- *Scientific research is* for the accuracy of ones findings:
 - Researchers must take great care in published reports to include information on their use of sampling methods, measurements, & data-gathering procedures.
 - Such information allows other researchers to verify independently a given study & to support or refute the initial research findings.



Characteristics of Scientific Research

■ Science is objective

- Science tries to rule out eccentricities of judgment by researchers.
- When a study is undertaken, **explicit rules & procedures** are constructed & the researcher is bound to follow them.
- Scientific research deal with facts rather than interpretations of facts.
 - Science rejects its own authorities if their statements are in conflict with direct observation.



Characteristics of Scientific Research

■ Science is empirical

- concerned with a world that is knowable & potentially **measurable**.
- Researchers must be able to perceive & classify what they study & to reject metaphysical & nonsensical explanations of events.
 - This does not mean that scientists evade abstract ideas & notions they encounter them every day.
 - But they recognize that concepts must be strictly defined [operational definitions] to allow for observation & measurement.



Characteristics of Scientific Research

■ Science is systematic & cumulative

- No single research study stands alone, nor does it rise or fall by itself.
 - Researchers are systematic & always utilize previous studies as building blocks for their own work.
- Moreover, scientists attempt to search for **order** & **consistency** among their findings.
- In its ideal form, scientific research begins with a single, carefully observed event & progresses ultimately to the formulation of theories & laws.



Characteristics of Scientific Research

■ Science is predictive

- Science is concerned with relating the present to the future.
- A theory's adequacy lies in its ability to predict a phenomenon or event successfully.
- If a theory suggests predictions that are not borne out by data analysis, that theory must be carefully reexamined & perhaps discarded.
- Conversely, if a theory generates predictions that are supported by the data, that theory can be used to make predictions in other situations.



Characteristics of Scientific Research

■ Science is replicable & verifiable

- Too often, researchers conduct one study & report the results as if they are providing the basis for a theory or law. However the results of any **single study are only indications** of what might exist.
- This means that others should have the opportunity to repeat a research project to see if the same results occur each time.
- **Replicable**—When scientists can recreate a previous research study, that study is replicable.
- **Verifiable**—When scientists can reproduce a previous research study & generate the same results, it is verifiable.



Types of Research

Descriptive vs. Analytical

■ Descriptive Research:

- includes surveys & fact-finding enquiries of different kinds.
- **Purpose** : *description of the state of affairs as it exists at present.*
- **Characteristic** :
 - the researcher has **no control over the variables**; he can only report what has happened or what is happening.
 - uses **description, classification, measurement, & comparison** to describe what phenomena are.
- **Methods**: survey methods



Descriptive vs. Analytical

■ Analytical research:

- the researcher has to use facts or information already available, & analyze these to make a **critical evaluation** of the material.
- usually concerns itself with **cause-effect relationships**.

■ Based on the questions raised:

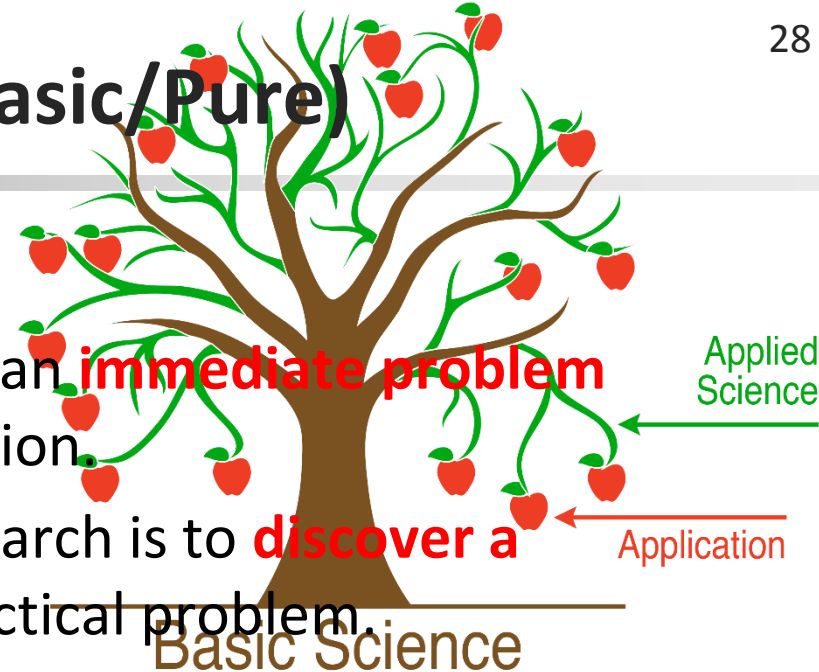
- Descriptive research attempts to determine, describe, or identify **what is**.
- Analytical research attempts to establish **why it is** that way or **how** it came to be.



Applied vs. Fundamental(Basic/Pure)

■ Applied research :

- **Purpose:** finding a solution for an **immediate problem** facing a society or an organization.
- The central aim of applied research is to **discover a solution** for some pressing practical problem.



■ Fundamental research :

- **Purpose:** generalizations & with the formulation of a theory.
 - Gathering knowledge for knowledge's sake
- directed towards finding information that has a broad base of applications to add the already existing organized body of scientific knowledge

Quantitative vs. Qualitative

■ Quantitative research

- based on the **measurement of quantity or amount**
- applicable to phenomena that can be expressed in terms of quantity
- usually involves collecting & converting data into **numerical form** so that statistical calculations can be made & conclusions drawn

■ Qualitative research

- concerned with **qualitative phenomenon**
- aims at discovering the underlying motives & desires using in depth **interviews** for the purpose
- specially important in the behavioral sciences



Quantitative vs. Qualitative

	Qualitative Research	Quantitative Research
Objective	understanding , description, hypothesis generation, discovery	Prediction, control, hypothesis testing, confirmation
Sample	Small number of non- representative cases	Large number of representative cases
Data Collection	Unstructured, interview & observation	Structured , questionnaire
Data Analysis	Non-statistical	Statistical
Outcome	Develop an initial understanding , comprehensive	Recommend a final course of action



Conceptual vs. Empirical

■ Conceptual research

- focuses on the **concept or theory** that explains or describes the phenomenon being studied.
- doesn't involve conducting practical experiments.
- Philosophers have long used conceptual research to develop new theories or interpret existing theories in a different light.
- The most famous example of a conceptual research is **Sir Issac Newton**.
 - He observed his surroundings to conceptualize & develop theories about gravitation & motion.
- Nowadays, conceptual research is used to answer business questions & solve real-world problems.



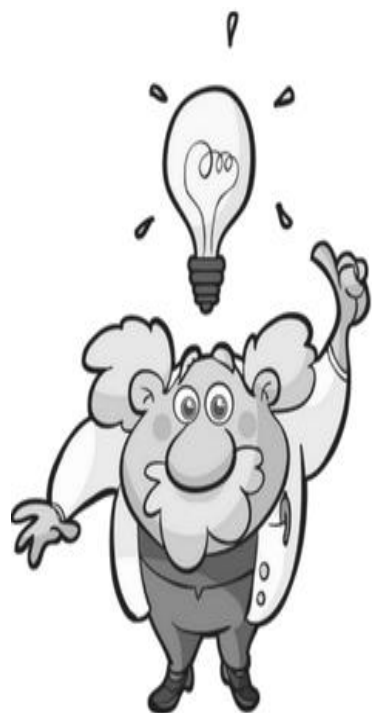
Conceptual vs. Empirical

■ Empirical/ Experimental research

- relies on experience or observation alone, often without due regard for system & theory.
- **data-based research**- coming up with conclusions which are capable of being verified by observation or experiment.
- Evidence gathered through experiments or empirical studies is considered to be the most powerful support possible for a given hypothesis.
- appropriate when proof is sought
 - *Aristotle taught that large cannonballs fell to earth faster than small ones, & many generations of professors repeated his teachings until Galileo proved them wrong.*



Conceptual vs. Empirical



Developing new concepts or theories like Aristotle!

Are you into conceptual or empirical research?



Experimenting to test theories or form basis for new theories like Edison!



Other types of research

- All other types of research are variations of one or more of the above stated approaches
- Based on time
 - ***one-time research*** - the research is confined to a single time-period
 - ***longitudinal research***-the research is carried on over several time-periods.
- Based on Environment
 - *field-setting research or*
 - *laboratory research or simulation research.*



Other types of research

- Research can as well be understood as *clinical or diagnostic research*.
 - Such research follows **case-study** methods or in depth approaches to reach the basic causal relations.
- The research may be *exploratory* or it may be formalized.
 - The objective of exploratory research is the **development of hypotheses** rather than their testing, whereas formalized research studies are those with substantial structure & with specific **hypotheses to be tested**.
- **Historical research** : utilizes historical sources to study events or ideas of the past.



Types of Research

■ Further Readings :

<https://koppa.jyu.fi/avoimet/hum/menetelmapolkuja/en/methodmap/strategies>

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Strategies

Navigationi

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 - Historical Research
 - Ethnographic Research
 - Hermeneutic Research
 - Narrative Research
 - Phenomenological Research
 - Discursive Approaches
 - Critical Research
 - Action Research

A research strategy is the overall plan, which a researcher uses to conduct a research project. A research strategy includes those methods of research with particular rules and aspects, which apply to a particular research project.

Research Processht... ^

Conceptual Resea....ht... ^



Reflective Thinking

Reflective Thinking

- What is research?
- Why we need to do a research?
- The various modes of accepting something as knowledge.
- What are the characteristics of scientific research?
- Mention the significance of research generally.
- Check your understanding about different types of research such as descriptive , analytical, qualitative , quantitative, conceptual, empirical & so on.



References

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