



IT Research Methods

The Research Process

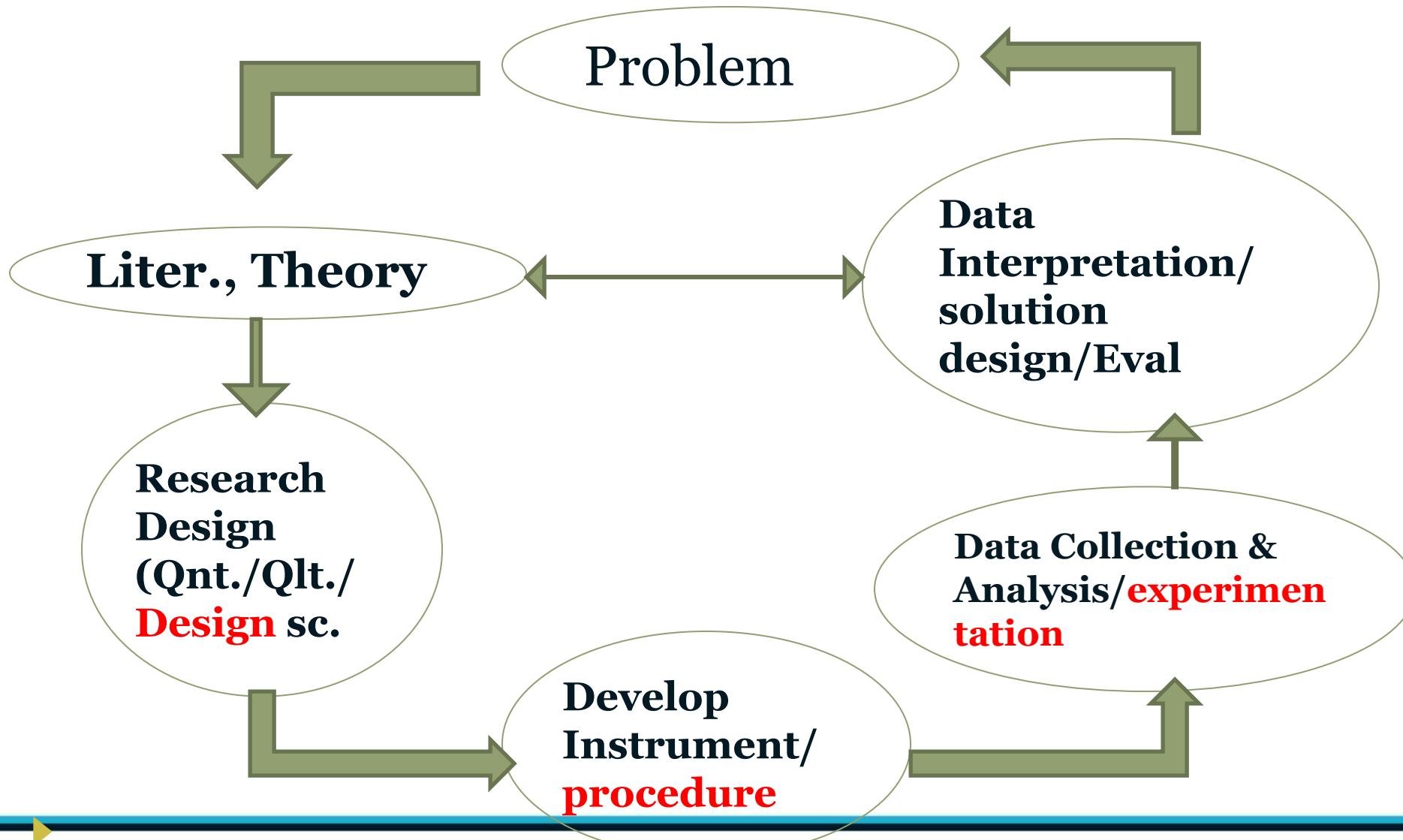


Topics- The Research Process

- **Step 1** -Problem- Selection (title) & formulation of Research Problem
- **Step 2** -Literature survey
 - (may also include development of objectives and working hypotheses)
- **Step 3** -Research design
 - (Pilot (quick) study) (**Step 4**- Developing Instruments)
- Research Execution
 - ❖ **Step 5**- Data collection, exp., analysis, Testing hypotheses
 - ❖ **Step 6**-, solution design, Interpretation & generalization
- **Step 7**- Preparation & writing of the report.
- **NOTE:** The above steps are not exhaustive, nor mutually exclusive, but a series of closely related, continuously overlapping and interdependent nonlinear steps/actions.

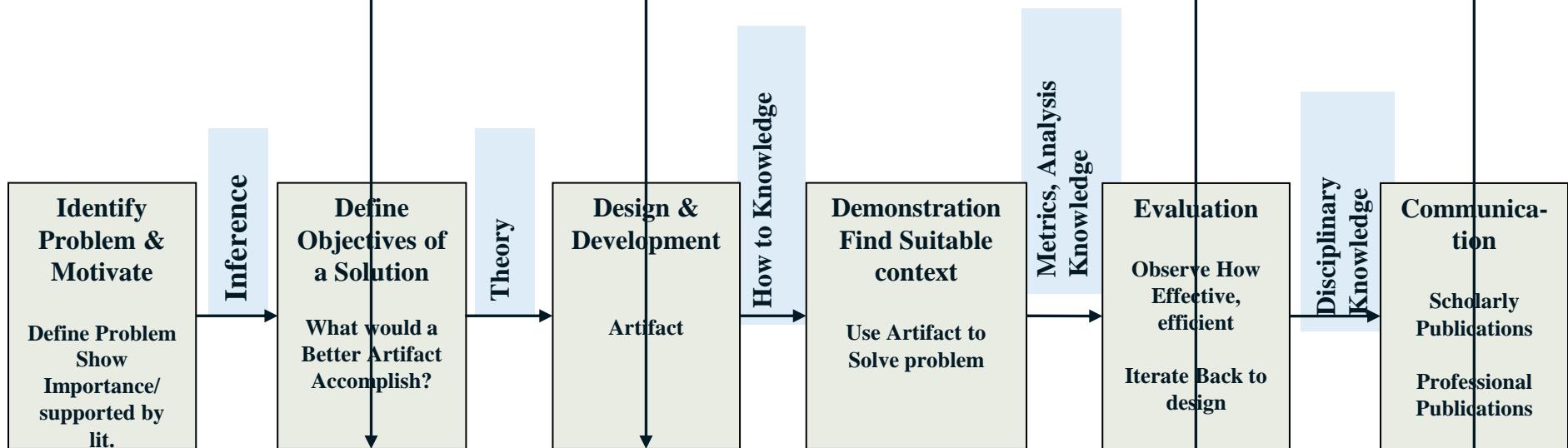


Research Process (general)





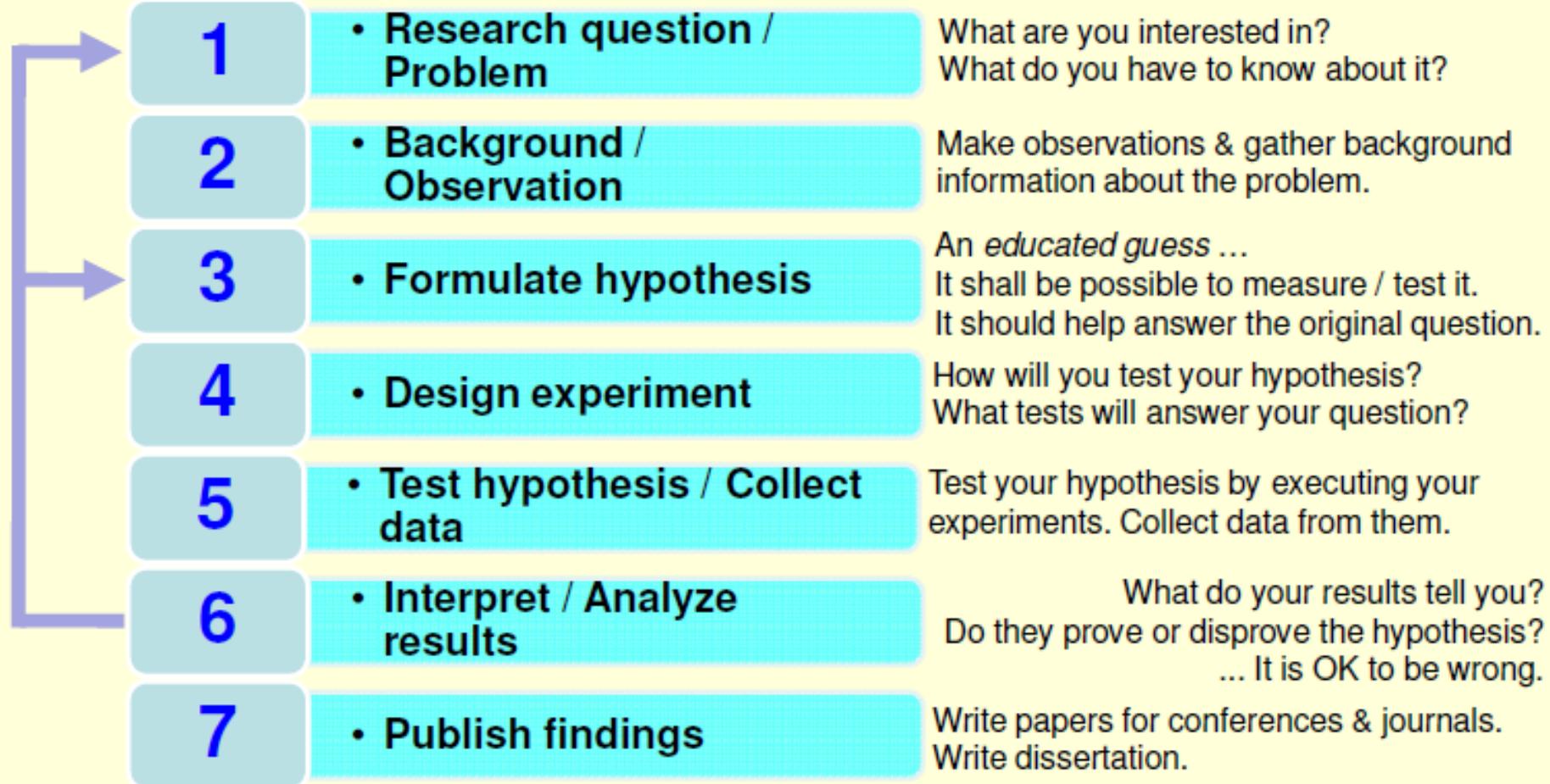
Design Research process



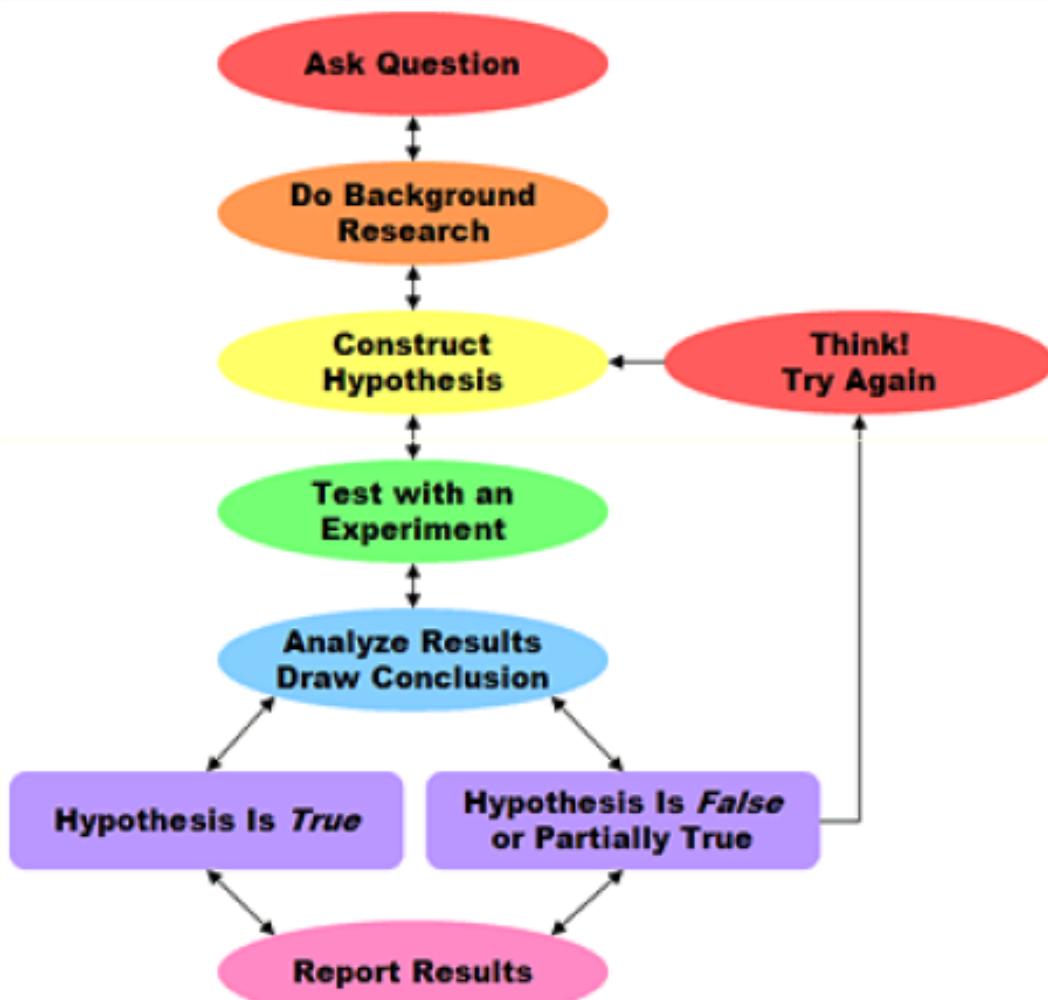
Process Iterations



Classical phases – experimental research



Other variants



1. Define the question
2. Gather information and resources (observe)
3. Form hypothesis
4. Perform experiment and collect data
5. Analyze data
6. Interpret data and draw conclusions that serve as a starting point for new hypothesis
7. Publish results
8. Retest (frequently done by other scientists)

[Wikipedia]



Problem- Selection (title) & formulation of Research Problem



Step 1: Problems/Questions- Topic

- Finding a research problem and formulating it in a manner that makes it susceptible to research is the first step in the research process.
- What is a research problem?
 - It is a difficulty one experiences in a theoretical or practical context for which a solution is needed.



General Sources of Research Problems

- **Personal observation of the environment**
 - ❖ Problems / opportunities
- **Literature reviews and future work recommendations**
 - ❖ Suggestions of previous researchers
- **Professional conferences/ Experts**
 - ❖ Domain experts and professionals talking on conferences



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■ Components of a research problem can be stated as:

- ❖ There must be an entity which has some difficulty or the problem.
- ❖ There must be some objective(s) to be attained. If one wants nothing, one cannot have a problem.
- ❖ There must be alternative means for attaining the objective(s).
- ❖ There must remain some doubt in the mind of a researcher with regard to the selection of alternatives.
- ❖ There must be some environment(s) to which the difficulty pertains.



Selecting a research problem

- **Points to be taken into account when a research problem is selected:**
 - ❖ Overdone subject should not be chosen.
 - ❖ Controversial subject should not become the choice of an average researcher.
 - ❖ Too narrow or too vague problems should be avoided.
 - ❖ The problem should be chosen in such a way that the ingredients required for the study should be within the reach of a researcher.



■ Cont'd..

- ❖ The importance of the subject, the qualifications and the training of a researcher, the costs involved, the time factor are few other criteria that must also be considered in selecting a problem.
- ❖ The selection of a problem must be preceded by a preliminary study. (for a field of inquiry that is relatively new)



Defining the research problem

- ***“A problem clearly stated is a problem half solved”***
- The problem to be investigated must be defined unambiguously in order to discriminate relevant data from the irrelevant ones
- **It helps answer questions related to:**
 - ❖ the data to be collected
 - ❖ the characteristics of the data that is relevant
 - ❖ the relations to be explored
 - ❖ the techniques to be used for the purpose and more



Techniques for defining a research problem

- **Defining a research problem takes the following steps:**

- ❖ statement of the problem in a general way
- ❖ understanding the nature of the problem
- ❖ surveying the available literature
- ❖ developing the ideas through discussions and
- ❖ rephrasing the research problem into a working proposition.



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■ Few rules that must be kept in mind while defining the research problem are:

- ❖ Technical terms in the statement of the problem should be clearly defined.
- ❖ Basic assumptions (if any) relating to the research problem should be clearly stated.
- ❖ A straight forward statement of the value of the investigation should be provided.
- ❖ The time-period and the sources of data available must also be considered
- ❖ The scope of the investigation or the limits within which the problem is to be studied must be mentioned explicitly.



What is NOT a Research Problem?

■ Not Comparing Data

❖ Example “This research project will compare the increase in the number of women students over 10 years from 1990 to 2000 with the men students over the same time span.”

■ Problems that Result in a Yes or No Answer

❖ Example, “ Is homework beneficial to children?”

❖ Compare the above example with:
““How does the amount and type of homework affect children’s academic performance and well-being?”



The problem statement

- After the research problem is identified, the next step is to write a problem statement.
- An effective problem statement is concise and concrete and should:
 - ❖ Put the problem in context (what do we already know?)
 - ❖ Describe the precise issue that the research will address (what do we need to know?)
 - ❖ Show the relevance of the problem (why do we need to know it?)
 - ❖ Set the objectives of the research (what will you do to find out?)



Aims and objectives

- **The aim of a research is the general purpose of the research and usually written in forms such as:**
 - ❖ The aim of this study is to **determine**...
 - ❖ This project aims to **explore**...
 - ❖ I aim to **investigate**...



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- **The objective is the concrete steps taken to achieve the aim:**

- ❖ Qualitative methods will be used to identify...
 - ❖ Survey will be used to collect...
 - ❖ Using statistical analysis, the research will measure...



Research Questions and hypothesis

■ Research question:

- ❖ Guides the research and pinpoints what is needed to be found out.

■ Research question should be:

- ❖ Focused on a single problem or issue
- ❖ Researchable using primary and/or secondary sources
- ❖ Feasible to answer within the timeframe and practical constraints
- ❖ Specific enough to answer thoroughly
- ❖ Complex enough to develop the answer over the space of a paper or thesis
- ❖ Relevant to your field of study and/or society more broadly



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- **Research questions are derived from the research problem at hand.**
- **Example**

Research Problem	Research Question (s)
Under-30s increasingly engage in the “gig economy” instead of traditional full-time employment, but there is little research into young people’s experiences of this type of work.	What are the main factors that influence young people’s decisions to engage in the gig economy? What do workers perceive as its advantages and disadvantages? Do age and education level have an effect on how people experience this type of work?



- **Hypothesis** is a predictive statement, capable of being tested by scientific methods, that relates an independent variable to some dependent variable.
- A hypothesis is not a guess - it should be based on existing theories and knowledge
- A hypothesis is derived from a research question or problem statement.



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- A hypothesis should be focused and specific and should contain:

- ❖ The relevant variables,
 - ❖ The specific group being studied, and
 - ❖ The predicted outcome of the experiment or analysis

- Example

- ❖ The *number of lectures attended by first-year students* has a positive effect on their *final exam scores*.



Cont'd..

■ Null Hypothesis vs Alternative Hypothesis

- ❖ The null hypothesis (written as H_0) is the default position that there is no association between variables.
- ❖ The alternative hypothesis (written as H_1) is the one that affirms the association between variables.

■ Example

H_0 : The number of lectures attended by first-year students has no effect on their final exam scores

H_1 : The number of lectures attended by first-year students has a positive effect on their final exam scores.



Evaluation of a research problem (some questions to ask)

- Is the problem in line with my goal/expectation and expectations of others
- Will the solution of the problem advance knowledge?
- What is the value of potential outcome? (who are the beneficiaries)
- Do I possess or can I acquire the necessary skills, abilities and background knowledge to study the problem? (Researcher's capability and interest)
- Will data be accessible?
- Do I have access to the necessary resources (time, money, tools, equipment, laboratory, subjects, etc) to conduct the investigation?



Step 2: Literature Survey

What is the purpose of literature review?



Literature Review

- It is a survey of scholarly works such as thesis and journal articles on a topic of interest.
- It gives an overview of key findings, concepts and developments in relation to a research problem or question



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- **There are three ends for which literature review is conducted:**

- ❖ For preliminary search to generate and refine research ideas
 - ❖ To provide context and theoretical framework for a research at hand, which is known as the Critical Literature Review (**the focus of this section**)
 - ❖ To place research findings within a wider body of knowledge



The Critical Literature Review

- The critical literature review is an analysis that develops an argument about what the published literature indicates is known and not known about your research question.
- It is not a simple summary of list of books and journals



Purpose and benefits of Literature review

- Critical review of the literature provides the foundation on which a research is built
- A critical review helps to develop a good understanding and insight into relevant previous research and the trends that have emerged
- It can show you how others have handled methodological and design issues in studies similar to your own
- It can reveal sources of data that you may not have known existed
- It can introduce you to measurement tools that other researchers have developed and used effectively



Types of critical review

■ Integrative review:

- ❖ critiques and synthesizes representative literature on a topic in an integrative way to generate new frameworks and perspectives on a topic.

■ Historical review:

- ❖ examines the evolution of research on a particular topic over a period of time to place it in an historical context.



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■ **Theoretical review:**

- ❖ examines the body of theory that has accumulated in regard to an issue, concept, theory or phenomenon.
- ❖ It is often used to establish a lack of appropriate theories or reveal that current theories are inadequate for explaining new or emerging research problems.



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■ **Methodological review:**

- ❖ focuses on research approaches, strategies, data collection techniques or analysis procedures.
- ❖ It is often used to provide a framework for understanding a method or methodology and to enable researchers to draw on a wide body of methodological knowledge.

■ **Systematic Review:**

- ❖ uses a comprehensive pre-planned strategy for locating, critically appraising, analyzing and synthesizing existing research that is pertinent to a clearly formulated research question to allow conclusions to be reached about what is known



Content of the Critical Review

■ In organizing the content of a critical review, you need to:

- ❖ include the key academic theories within your chosen area of research that are pertinent to contextualize your research question;
- ❖ demonstrate that your knowledge of your chosen area is up to date;
- ❖ enable those reading your project report to find the original publications which you cite through clear complete referencing.



The following questions can be asked to evaluate the critical review:

- ❖ Have you ensured that the literature covered relates clearly to your research question and objectives?
- ❖ Have you covered the most relevant and significant theories of recognized experts in the area?
- ❖ Have you covered the most relevant and significant literature or at least a representative sample?
- ❖ Have you included up-to-date relevant literature?
- ❖ Have you properly referenced all the literature used?



General guideline for structuring the literature review

1. start at a more general level before narrowing down to your specific research question(s) and objectives;
2. provide a brief overview of key ideas and themes;
3. summarize, compare and contrast the research of the key authors;
4. narrow down to highlight previous research work most relevant to your own research;
5. provide a detailed account of the findings of the researches and show how they are related;
6. highlight those aspects where your own research will provide fresh insights;
7. lead the reader into subsequent sections of your project report, which explore these issues.



Literature Sources

- The sources of literature can be grouped in general into:
 - ❖ **secondary literature sources:** formally published items such as journals and books
 - ❖ **grey (or primary) literature sources:** produced by all levels of government, academics, business and industry in print and electronic formats, but which are not controlled by commercial publishers



Main sources of literature

Source	Content	Use for the literature review
Refereed (peer-reviewed) academic Journal	Detailed reports of research. Written by experts and evaluated by other experts to assess quality and suitability for publication. Rigorous attention paid to detail and Verification	Most useful of all
Non-refereed academic journal	May contain detailed reports of research. Selected by editor or editorial board with subject knowledge	Varies considerably Beware of bias
Professional Journals	Mix of news items and practical detailed accounts. Sometimes include summaries of research	Insights into practice but use with caution



Cont'd..

Source	Content	Use for the literature review
Trade journals/ Magazines	Mix of news items and practical detailed accounts	Insights into practice but use with caution
Books and e-books	Written for specific audiences. Usually in an ordered and relatively accessible format. Often draw on wide range of sources	Particularly useful for an overview and to find recognized experts
Newspapers	Written for a particular market segment. Filtered dependent on events. May be written from particular viewpoint	Good for topical developments. Beware of possible bias in reporting and coverage
Conference Proceedings	Selected papers presented at a Conference	Can be very useful if on same theme as research



Cont'd..

Source	Content	Use for the literature review
Reports	Topic specific. Written by academics and organization. Those from established organizations often of high quality	Very useful, when matches your topic
Theses	Often most up-to-date research but very specific	Good for PhD and MPhil research degrees, otherwise less useful



Where to Begin searching

- **Library catalog** – Locate books relevant to your research topic – may be general textbooks in your discipline or collections of articles written by a variety of experts in the field
- **Indexes and Abstracts** – Begin with periodicals in your academic area – Computer Science/software engineering/ IT
- **Online databases** - Access to the literature which contain enormous collections of citations or abstracts related to various subjects and disciplines



Cont'd..

- **Government publications**
- **The World Wide Web, (Google scholar, Research Gate , University websites...)**
- **The citations and reference lists of those who have gone before you** – track down *any references that you see cited by three or more other researchers* because such references are clearly influencing current work in your field and should not be overlooked. Whenever possible, *go to the original source and read it yourself* since most authors misrepresent the work of a particular researcher in the same, particular way; apparently, they are reading one another's descriptions of that researcher's work rather than reading the researcher's own words!



Literature Review Pitfalls

- **Be very careful to check your sources when doing your literature review.**
- **Many trade magazines are not peer reviewed.**
 - ❖ Professional conferences and journals often have each article reviewed by multiple people before it is even recommended for publication.
 - ❖ The IEEE and ACM digital libraries are good places to start looking for legitimate research.



Literature Review Pitfalls (cont.)

- The Internet can be a good source of information. It is also full of pseudo-science and poor research.
- Make sure you verify the claims of any documentation that has not been peer reviewed by other professionals in the computing industry.



Development/revisiting of objectives, Research questions and working hypotheses



Cont'd....

- After comprehensive literature review there may be a need to revisit problem statements, objectives, hypothesis and/RQ
- If you do not have a clearly stated objective yet, it is time now to craft a general and specific objectives
 - ❖ General objective is just one sentence in a deliverable oriented format and agreed with the title
 - ❖ Specific objectives are list of action statements collective achievement of which will enable the attainment of the general objective.



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■ Some guidelines in developing objectives:

- ❖ Objectives must be specific, concrete and achievable statements;
- ❖ The objectives should clearly fit to the statement of the problem;
- ❖ the objectives must propose to do things as per the capability of the design of the study;



Cont'd..

■ A hypothesis must be:

- ❖ Specific;
- ❖ Conceptually clear in terms of common definitions;
- ❖ Testable (verification or rejection) by available techniques and resources;
- ❖ Related to a body of theory;
- ❖ Stated to provide direction for the research;
- ❖ Formulated as causal relationship



Cont'd..

■ *Research question*

- ❖ In cases where we don't have a hypothesis, a problem statement should end with a research question
- ❖ Putting the problem in a question form so that it guides the research process.
- ❖ How many RQ
 - You may have 3-5
 - Some say research may only have one



RQ example

Multiple questions

- Q1: Does participation in a one-week teacher professional development around the Exploring Information Systems curriculum result in improved teaching practices?
- Q2: Does participation in a one-week teacher professional development around the Exploring Information Systems curriculum result in more frequent use of inquiry-based learning pedagogical methods?

One question

- What effect does daily use of Facebook have on the attention span of under-16s?



Step 3: Research Design

- **If you fail to plan, you planned to fail !**
- **Research Design is a comprehensive master plan of the research .**
 - ❖ It is also an important part of the research proposal
- **It is a framework that guides how the research question will be answered.**
- **It includes:**
 - ❖ Philosophical assumption, General Research methodology (approach)-Specific method, Data collection techniques, Data analysis, and solution development, Evaluation/validation



Cont'd..

■ A research design will:

- ❖ contain clear objectives derived from your research question(s),
- ❖ specify the sources from which you intend to collect data,
- ❖ how you propose to collect and analyze the data, and
- ❖ Discuss ethical issues and the constraints you will inevitably encounter (data, time, money, ..)



Which research design is the best?

- There is no one-size-fits-all research design solution.
- The research problem determines the type of design to be used, not the other way around.
- Though researchers often tend to choose a research design they are comfortable with, the research phenomenon should be the one that dictates the research design.



Cont'd..

■ For example:

- ❖ If alternative research problems in a domain are being explored for scoping out the nature of a problem, **Case Study** can be an appropriate strategy.
- ❖ In an area where there are no good theories, an attempt to develop one can be achieved through **Grounded Theory**.
- ❖ **Experimental design, Survey research** and the like could be more appropriate in a domain where there are competing theories and theory testing is the objective of the research.



Cont'd..

■ For example:

- ❖ Introduction of intervention and observation of its impact is what is to be done, **Action Research** will be an appropriate strategy.
- ❖ If a research has development of artifacts (Constructs, Models, Methods, instantiations) that address problems as its aim, **Design Science** research will be the strategy to adopt.



Cont'd..

- **The research design, appropriate for a particular problem, involves the consideration of:**

- ❖ The time available for the research
 - ❖ The finance available for the purpose
 - ❖ The skills of the researcher
 - ❖ Identifying the study variables
 - ❖ Identifying study subjects/experimental units
 - ❖ Planning the means of obtaining the information and reasoning leading to selection
 - ❖ Sampling



Step 4: Develop Instruments/procedures

- **Can also be part of the research design**
- **Instrument**
 - Refers to measurement tools (Questionnaire, Interview, Observation..) used to obtain data on a topic of interest from research subjects.
 - Can be developed in two possible ways:
 - adopting from literature and
 - crafting based on objectives/RQ
- **Instrumentation**
 - Is the process of developing, testing and using instruments



Cont...

- **For example, to use an existing instrument:**

- Describe the established validity scores (such as Construct Validity) from past use.
- Describe also the score for the reliability of the instrument

- **When an instrument is modified:**

- Reestablishing Validity and Reliability is important as past scores may not hold for the new instrument.



Pilot testing instruments

- **Pilot testing of instruments is important:**
 - ❖ To ensure that the instrument is a valid and reliable measure of the constructs of interest.
 - ❖ To detect potential problems in the instrument in terms of intelligibility by the target sample.
- **After successful pilot testing, instruments can be used to collect data from the sampled population**



Cont'd

■ Procedure

- ❖ Tells the reader how the data will be collected
- ❖ Clearly shows the order in which things occur
- ❖ States how the sample is recruited
- ❖ Notes who collects the data
- ❖ States clearly all processes or activities participants engage in
- ❖ Notes where all the activities take place



Step 5: Data Collection and Analysis

■ **Data Collection**

- ❖ Is a systematic process of gathering data on variables of interest to the research questions.
- ❖ Data is collected in all of researches irrespective of their type and nature.
- ❖ The appropriate data collection method will be different based on the nature of the research.
- ❖ Accurate data collection is essential for ensuring the integrity of the research.
- ❖ Selecting the appropriate instrument and clearly defining their right use reduces the likelihood of occurrence of errors.



Cont'd..

■ Data can be collected from Primary and Secondary sources:

- ❖ Primary data is collected through methods like:
 - Interview
 - Questionnaire
 - Observation ...
- ❖ Secondary data is obtained from:
 - Journals
 - Books
 - Magazines ...



Cont'd...

■ **Analysis**

- ❖ The data that is collected is analyzed and, depending on the nature of the research, prediction, or explanation or sense-making will be done.

■ **Quantitative** researches involve statistical analyses, for the most part.

- ❖ Descriptive Statistics
- ❖ Inferential statistics

■ **Qualitative** researchers use words to understand and describe the phenomena

- ❖ Coding /pattern matching /narration



Step 6: Result/solution design

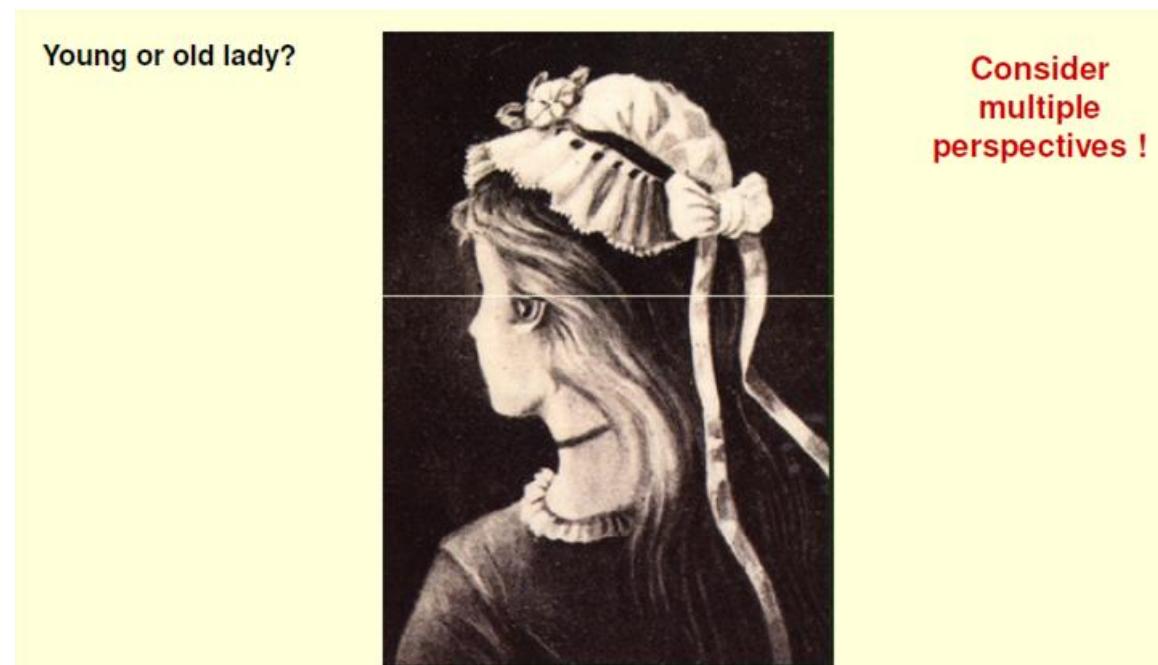
Interpretation

- The researcher discusses/interprets the newly analyzed data or provide solutions (implementations) and suggests a conclusion.
 - Interpretation means identifying relationship between variables/and or other works to draw conclusions
 - Provide lessons from designing a solution or doing experimentations
 - Evaluation of the results
 - Meaning of Testing hypothesis if any – Reject or Accept
 - Providing explanations for accepting or rejecting / how novel or new the result is....



Cont'd..

- What did your analysis/experiment/design show?
- Discussion in light of Literature, Research objectives and Research questions.





Cont...

- **The evaluation/testing in experimental and design research will indicate further work too.**
 - ❖ This may lead the researcher to cycle back to an earlier step in the process and begin again with a new hypothesis.
 - ❖ This is one of the self-correcting mechanisms associated with the scientific method.



Cont'd..

- In sum, this section should focus mainly on the following elements:
 - ❖ **Interpretations:** what do the results mean?
 - ❖ **Implications:** why do the results matter?
 - ❖ **Limitations:** what can't the results tell us?
 - ❖ **Recommendations:** what practical actions or scientific studies should follow?



Step 7-Proposal /Report writing

- Last step?
- There are basically two main documents in the process of a research.
 - ❖ A proposal
 - ❖ A final report (conference paper, journal article, thesis, dissertation...)
- Slight differences on the format of content and structure.



Cont'd..

- A research result is not a contribution to the field if no one knows about it or can use it.
- Research works need to be reported in the form of scientific papers and presented at the right place:
 - ❖ Intermediate results
 - Conferences
 - Collect feedback
 - ❖ Consolidated results
 - Journals