How to Conduct a Scientific Research

Dr. Mohd Abdur Rashid

Professor, Department of EEE

Noakhali Science and Technology University (NSTU)
Bangladesh.

Biography

Mohd Abdur Rashid received Ph.D. in Electrical and Information Engineering from University of the Ryukyus, Japan. He is currently working as Professor in EEE Department at NSTU, Bangladesh. He also worked as a faculty member in Malaysia for six years, and as Post-Doctoral Fellow for three years in Japan and Canada. He has authored more than 95 technical papers in journals and conferences. His research interests are multidisciplinary fields including mathematical modeling, electronic devices and biomedical engineering.

Outline of Talk

- What is Research?
- Steps of Scientific Research
- Selection of Research Area and Topic
- Research Question
- Literature Review
- Research Hypothesis
- Research Goal & Objectives
- Research Horizons

What is Research ?

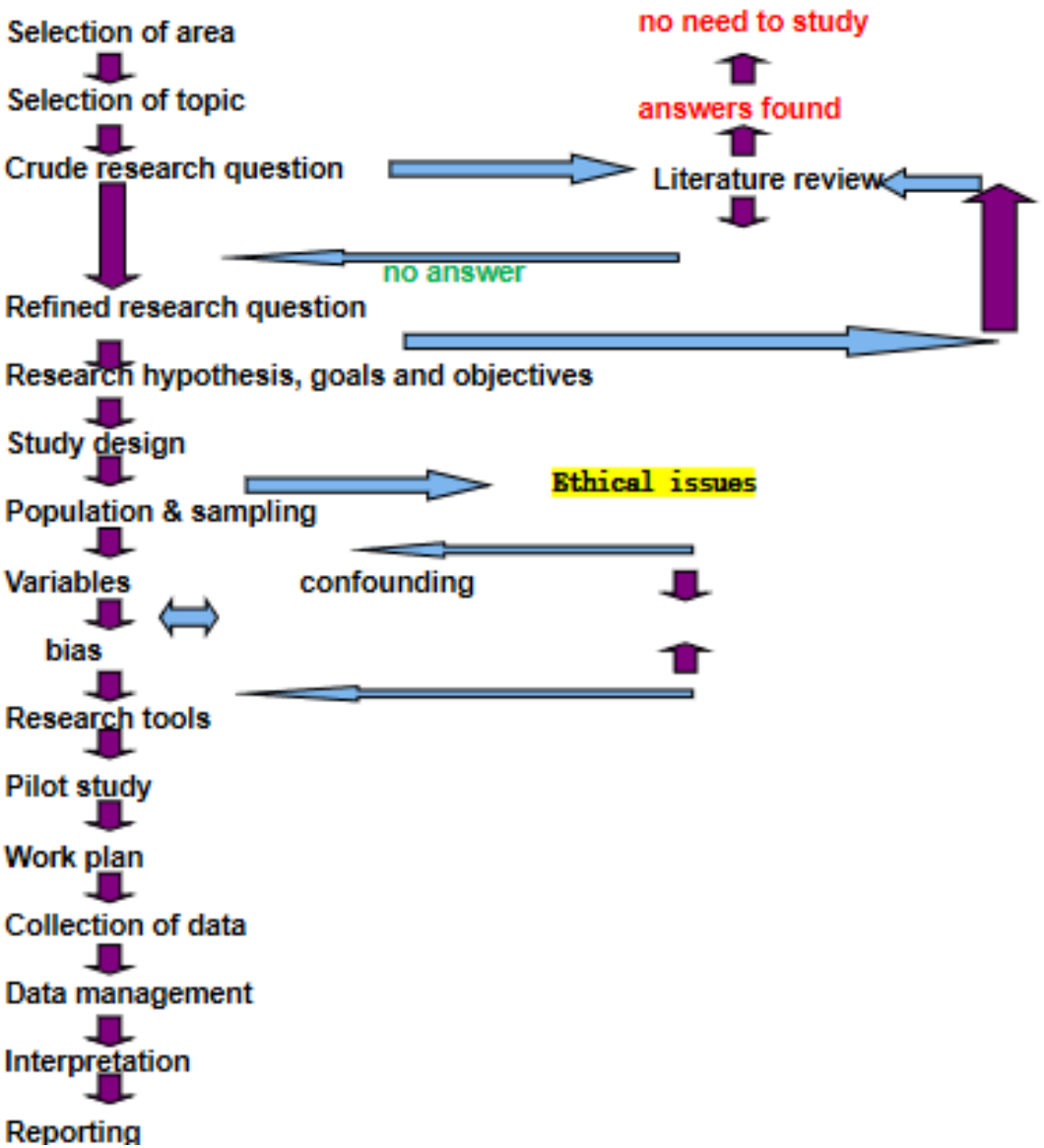
- Research is to:
  - Discover new knowledge
  - Seek answer to questions
  - Enhance knowledge
- Basic research
  - Driven by curiosity for fundamental/general knowledge/understanding
  - High impact example: relativity theory
- Applied research
  - Driven by practical needs.
  - High impact example: computers

Others must learn something new from your work that can't be learnt from any existing literature.

Types of Research

Research	Methods	Strengths	Drawbacks
Descriptive Research	Snapshot of thoughts, feelings or behaviors	Allow capturing the complexities of everyday behavior. Provides detailed picture of what is occurred at a given time.	Cannot answer how a certain behavior develops, what impact the behavior has, and why the behaviors was performed.
Co relational Research	Systematic Relationships among variables **Pearson's correlation coefficient**	Allow testing of expected relationships among variables and making of predictions.	Cannot identify causal relationships among variables. Remains a possibility that other variables caused observed variable to be correlated.
Experimental Research	Causal relationships of more than two variables	Allow drawing of conclu-sion about the causal relationships among variables.	Cannot experimentally manipulate many important Variables.

Steps of Scientific Research



Selection of Research Area

- Researcher's:
  - Specialty
  - Interest
  - Scientific background
  - Experience
- Actual need for research in this area
- Available resources

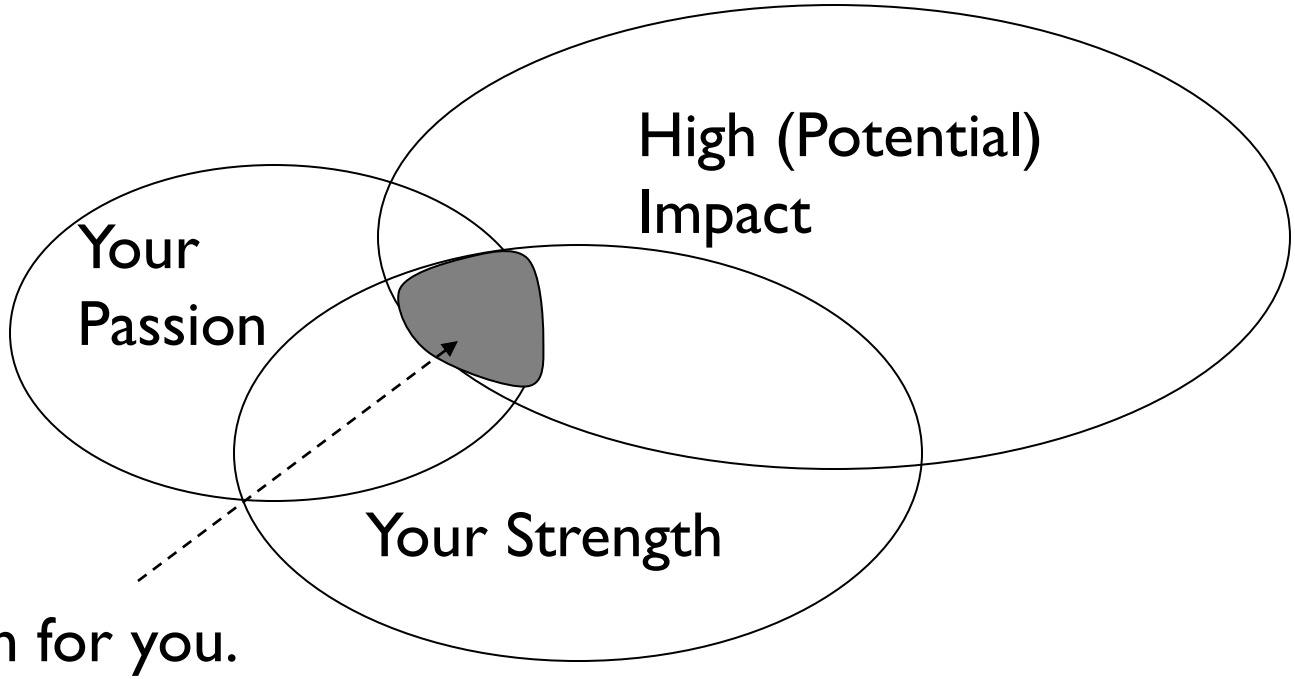
Selection of Research Topic

The priority of research topic depends on:

- The characteristics of the problem:
  - Magnitude
  - Seriousness
  - Available alternatives
  - Proposed solutions

- The characteristics of the proposed study:
  - Feasibility
  - Cost-effectiveness
  - Applicability of the results
  - Social and Environmental impact

Optimizing "Research Return": Pick a Problem Best for You



Find your strength/Avoid your weakness:

What are you (not) good at ?

Research Question

The investigator must make sure that:

- He has a **research question.**
- The question is **clear** and **specific.**
- It **reflects the objectives** of the study.
- It has no answer by **common sense.**
- It has no answer in the **Literature.**
- Finding an answer to the question **will solve or at least help in solving the problem to be investigated**.

What is “Literature Review”?

- “… literature review surveys scientific articles, books, journals, dissertations and other sources […] relevant to a particular issue, area of research, or theory, providing a description, summary, and critical evaluation of each work.”

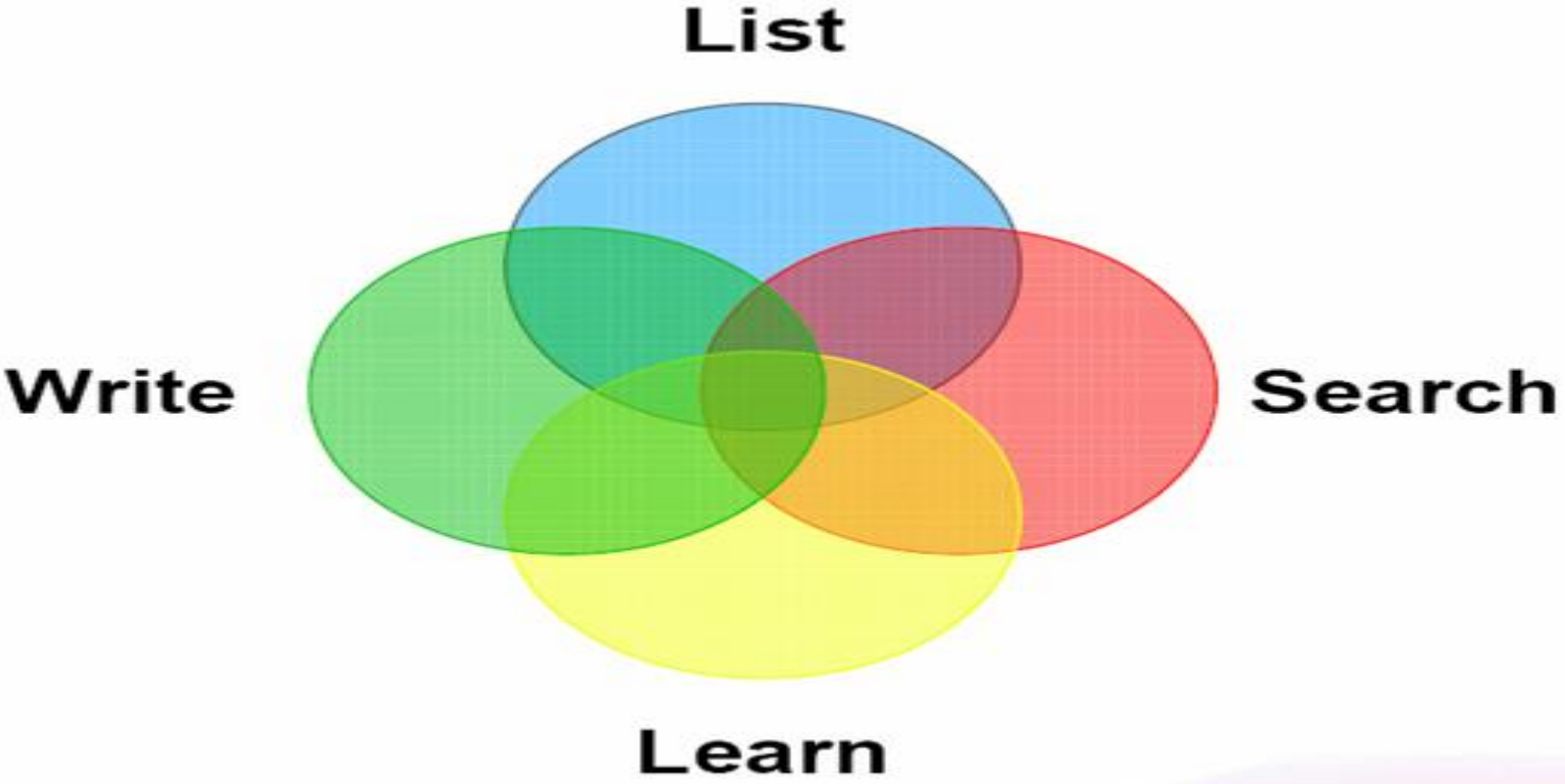
Literature Review

Purpose of Literature Review

A literature review may constitute an essential chapter of a thesis or dissertation. In either case, **its purpose is to:**

- Place each work in the context of its contribution to the understanding of the subject under review.
- Describe the relationship of each work to others under consideration.
- Identify new ways to interpret, and shed light on any gaps in, previous research.
- Resolve conflicts amongst contradictory previous studies.
- Identify areas of prior research to prevent duplication of effort.
- Place one's original work (in case of thesis/dissertations) in the context of existing literature.

Literature Review as a Process

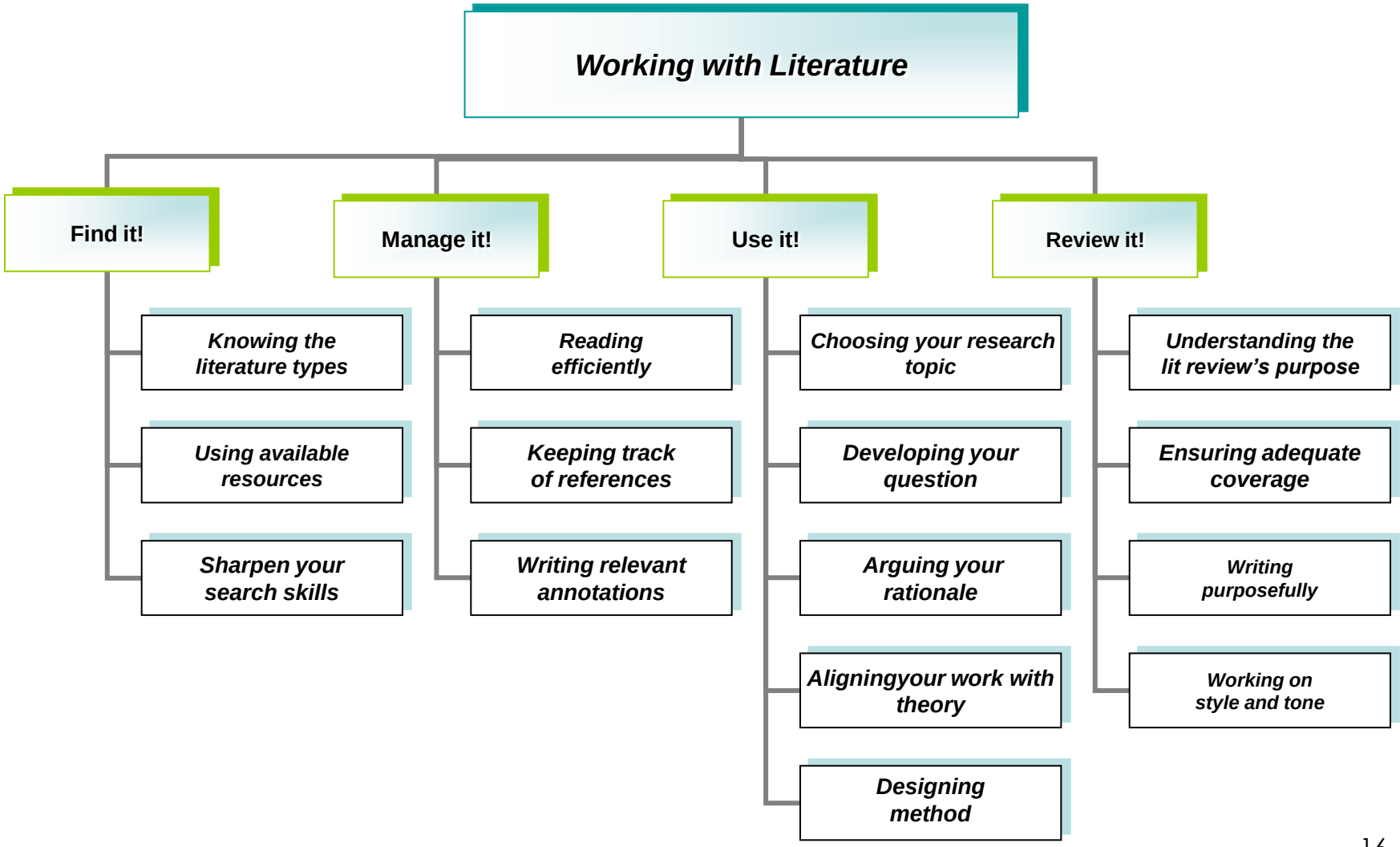


Components of Literature Review

Development of literature review requires four stages:

- **Problem formulation**:—which topic or field is being examined and what are its component issues ?
- **Literature search—**finding materials relevant to the subject being explored.
- **Data evaluation—**determining which literature makes a significant contribution to the understanding of the topic.
- **Analysis and interpretation—**discuss the findings and conclusions of pertinent literature.

Working with Literature



Sources of Literature

Journal articles:

- best sources
- concise up-to-date information.
- refereed materials.

What about Non-refereed Journals?

Trade Journals / magazines use less rigorous standards of screening prior to publication.

Non-refereed materials are not checked as intensely as refereed materials. **Not good sources of literature and research.**

Sources of Literature (cont.)

Books:

- Remember, books tend to be less up-to-date, as it takes longer time to get published than for a journal article.

- They are still likely to be useful for including in your literature review as they offer a good starting point from which we can get more detailed and up-to-date information.

Sources of Literature (cont.)

Conference proceedings:

- Useful in providing the latest research, or research that has not been published.
- Helpful in getting information about people in different research areas.
- Helpful in tracking down other works by the same researchers.

Sources of Literature (cont.)

Government/corporate reports:

- Many government departments and corporations carry out research works.

- Their published reports can be very useful sources of information, depending on your field of study.

Sources of Literature (cont.)

Thesis / Dissertations:

- These can be very useful sources of information. However, there are some disadvantages.

➢ difficult to obtain since they are not published.

➢ Available only from the library or inter-library systems.

- Student who carried out the research may not be an experienced researcher. Therefore you have to consider their findings with more caution than published research.

Sources of Literature (cont.)

Internet:

- Internet is the fastest-growing source of information.
- bear in mind that anyone can post information on the Internet so the quality may not be reliable.
- the information you find may be intended for a general audience and so not be suitable for inclusion in your literature review (information for a general audience is usually less detailed).

Additional Resources

- http://scholar.google.com/
- http://ieeexplore.ieee.org/Xplore/
- http://www.scopus.com/home.url
- http://www.ncbi.nlm.nih.gov/pubmed

Additional Resources (cont.)

- http://highwire.stanford.edu/lists/freeart.dtl
- http://www.jstor.org/
- http://www.ojose.com/
- http://www.springer.com/

Additional Resources (cont.)

- http://pubs.acs.org/page/publish-research/episode-1.html
- http://www.lib4ri.ch/files/2014_07_oa_journals_scie.xls
- http://doaj.org/
- www.dovepress.com
- http://www.elsevier.com/ data/assets/pdf_file/0005/116447/how-to-write-a-world-class-paper.pdf
- http://taiwan.elsevier.com/htmlmailings/AuthorWorkshop-_SP-PPT-Sep%2009.pdf
- http://www.utsa.edu/lrsg/Teaching/GEO6011/HowToWriteP_aper.pdf
- http://lib.semi.ac.cn/tshg/pxjs/How%20to%20Write%20a%20World%20Class%20Paper%20(THEORETICAL).pdf

Additional Resources (cont.)

- http://informahealthcare.com/doi/abs/10.1185/03007995.2010.499344
- http://library.ufs.ac.za/dl/userfiles/Documents/00000/512_e_ng.pdf
- http://pubs.acs.org/bio/ACS-Guide-Writing-Manuscripts-for-_the-Digital-Age.pdf
- https://www.dur.ac.uk/library/research/training/
- https://www.dur.ac.uk/library/research/bibliometrics/
- http://books.google.com.my/books?isbn=1107670748
- http://books.google.com/books?isbn=1846194083
- http://books.google.com/books?isbn=1409485439

Selecting Papers Digitally

Command	Purpose
AND	Look for articles that include all search terms/keywords.
OR	Look for articles that include any of the search terms.
NOT	Exclude articles that include specific keyword.

When you are on track,
Search again on your chosen field !!!

Assessment of a paper

In assessing each piece, consideration should be given to:

- **Origin—**What are the author's credentials? Are the author's arguments supported by evidence (e.g. primary historical material, case studies, narratives, statistics, recent scientific findings)?

- **Objectives—**Is the author's perspective even-handed or prejudicial? Is certain pertinent information ignored to prove the author's point?

- **Significance—** is the author’s work convincing?

- **Value—**Does the work contribute in any significant way to an understanding of the subject of my research?

Information Collection from a Paper

Information should be collected from the following four components:

- The introduction
- The body
- Result & Discussion
- The conclusion

Information from Introduction

In introduction, you should:

- identify the general topic, area of concern, thus providing an appropriate context for reviewing the literature.
- Point out overall trends in what has been published about the topic; or conflicts in theory, methodology, evidence, and gaps in research.
- Establish the writer's reason (point of view) for reviewing the literature; explain the criteria to be used in analyzing and comparing literature.

Information from Body

In the body, you will find:

- Group research studies and other types of literature (reviews, theoretical articles, case studies, etc.)
- such as qualitative versus quantitative approaches,
- conclusions of authors,
- specific purpose or objective, etc.

Information from Result

- Finding of individual studies
- comparisons with other studies
- Analyses of the findings.
- Positive side of the paper
- Significance of the paper

Information from Conclusion

In the conclusion, you will find:

- Major contributions of studies and articles to the body of knowledge under review, maintaining the focus established in the introduction.
- Evaluation of current "state of the art" pointing out major methodological flaws or gaps in research, inconsistencies in theory and findings, and areas o future study.
- Insight into the relationship between the central topic of the literature review and a larger area of study.

A few things those worked for me…

- Use effective search strategies.
- Collect reliable journal (IEEE, IET preferred)
- Don’t write a literature review.
- Point out **everything** you read.
- Write summary with **positive** and **negative** findings.
- Formulate research gaps from **negative** findings.

A few things those worked for me…(cont.)

- Find out which you **believe** that you can solve.
- Fix your **Problem statement.**
- Ask questions !

Research Hypothesis

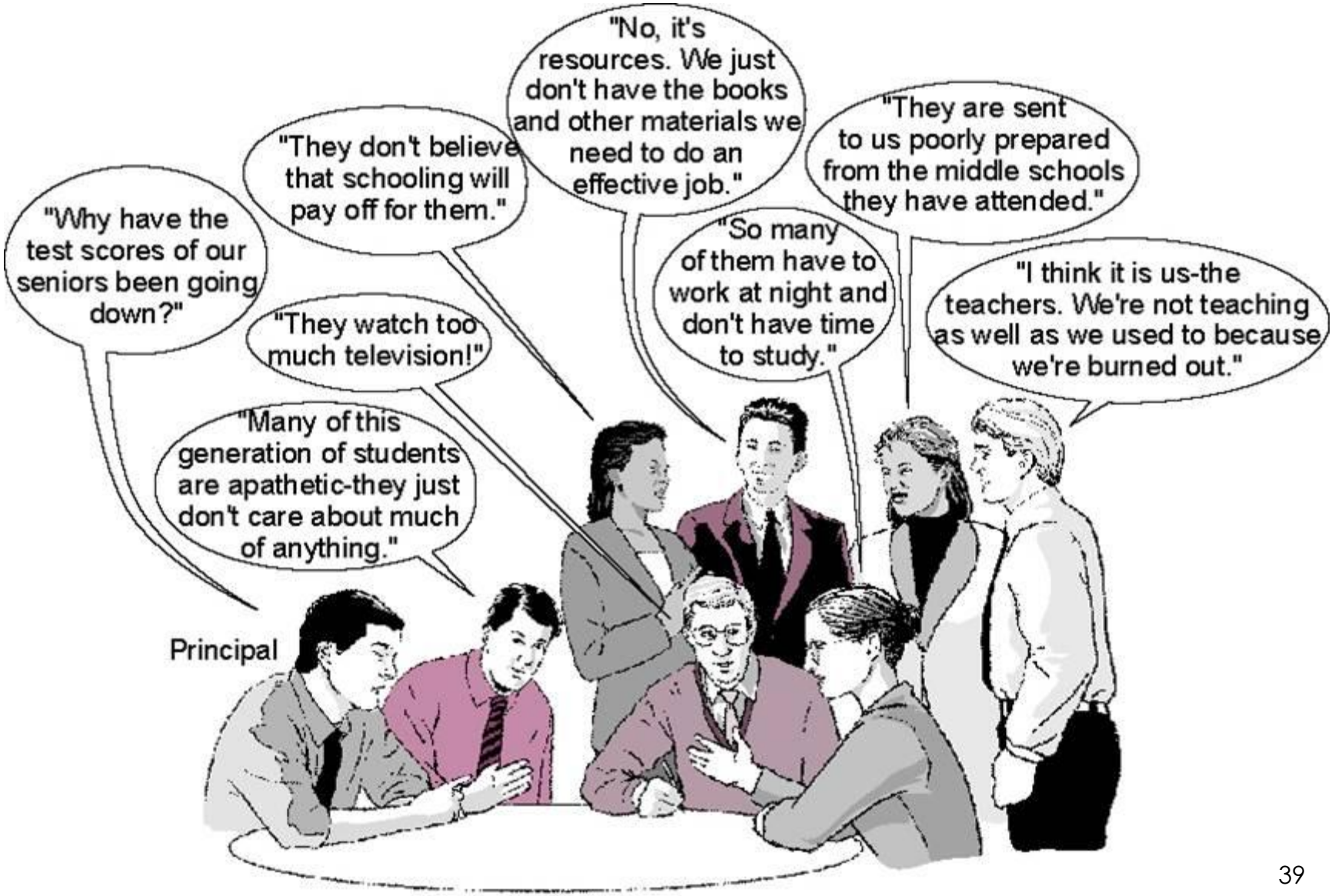
- “ Research hypothesis is a statement of the research question in a measurable form”

  - Null hypothesis
  - Alternative hypothesis

Research Hypothesis (cont.)

- A hypothesis can be defined as a prediction or explanation of the relationship between one or more independent variables and one dependent variable.
- A hypothesis, in other words, translates the problem statement into a precise, clear prediction of expected outcomes.
- It must be emphasized that hypotheses are not meant to be haphazard guesses, but should reflect the depth of knowledge, imagination and experience of the investigator.

Hypothesis from a Research Question



Directional vs. Non-directional Hypothesis

A directional hypothesis is one in which the researcher indicates the specific direction that he expects in the study.

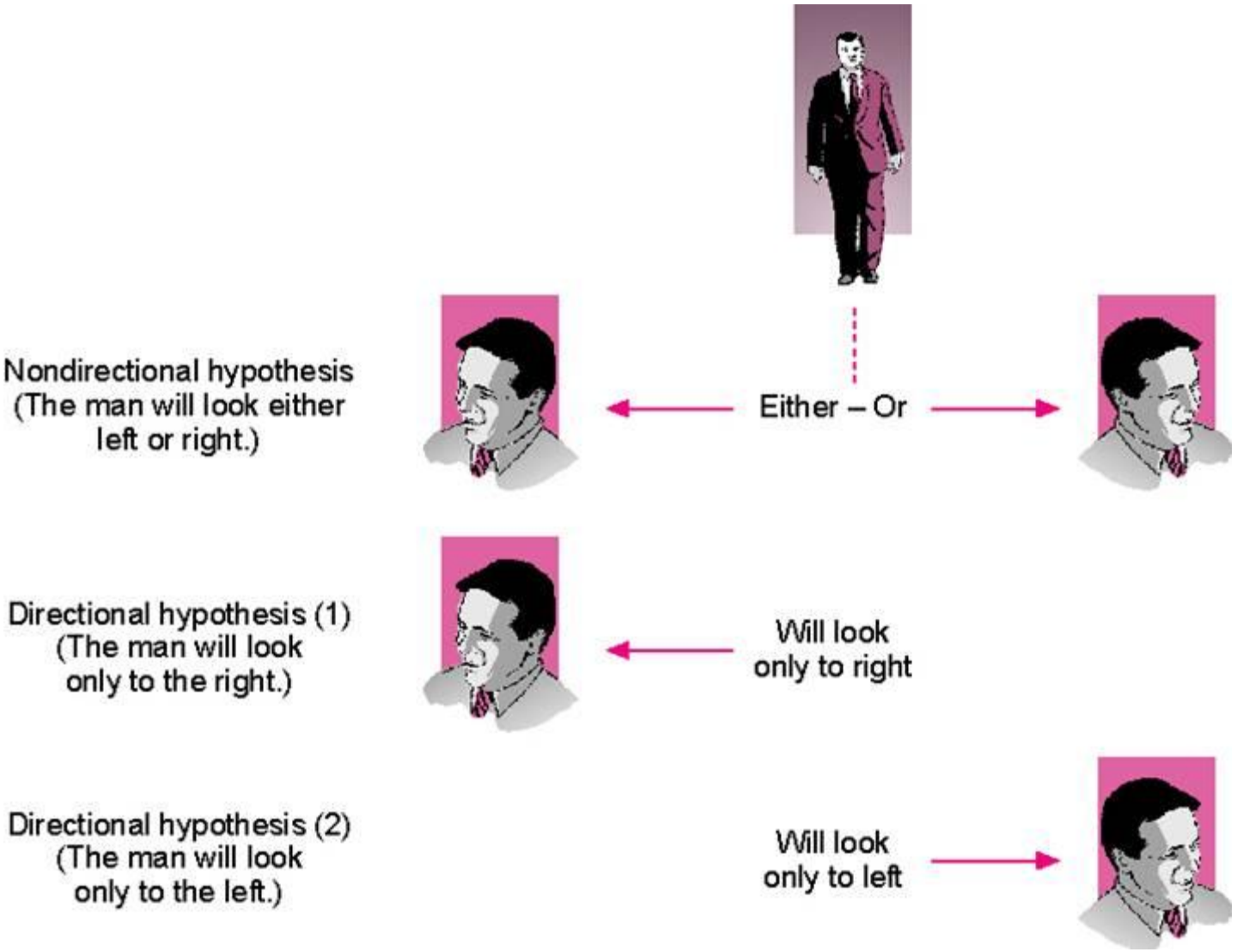
The direction is based on what the researcher has found from:

- Literature
- Personal experiences
- Experience from others

A non-directional hypothesis is when there is no specific prediction about what direction the outcome of a study will take.

- Sometimes it is difficult to make specific predictions on the study.
- A study may state that it would point to non-specific directions vs. distinct possibilities

Directional vs. Non-Directional Hypothesis



Research Goals and Objectives

Goals $\neq$ **Objectives**

Research Goal and Objectives

- The goal (aim) and objectives must be stated at the very beginning of the study, since they will guide the investigator during the process of formulating research questions and hypothesis.

- They will also help in the prioritization process.

- They will enable the reader to judge whether the investigator had achieved these objectives or not.

Research Goals

- It describes the aim of work in broad terms.

Research Objectives

These are more specific and relate directly to research question. These are divided into two types:

- Primary objectives → (must be achieved)
- Secondary objectives → (may by achieved)

Research Objectives

The research objectives should be:

- Closely related to the research question
- Covering all aspects of the problem
- Very specific
- Ordered in a logical sequence
- Stated in action verbs that could be evaluated e.g. to describe, to identify, to measure, to compare, etc.
- Achievable, taking into consideration the available resources and time
- Mutually exclusive, with no repetitions or overlaps

SMART Objectives

- S → Specific
- M → Measurable
- A → Achievable
- R → Relevant
- T → Time-bound

Research objectives

- Properly formulated, specific objectives
  - will facilitate the development of your research methodology

and

  - will help to orient the collection, analysis, interpretation and utilization of data.

Example:

- **Area:** Solid State Device Design
- **Topic:** Performance Improvement of Quantum Dot Based Laser Using InN
- **Goal:** to improve overall performance of laser
- **Objective:**
  - To resuce the internal losses of laser
  - To enhance the gain/amplification
  - To improve the efficiency

Research Horizons

- Never define success
- Stick to one topic for whole career
- Even if technology appears to leave you behind, stand by your problem.
- Let complexity be Your Guide
- Ready to be proven wrong
- Don’t be distracted by others

“If we knew what we were doing, it wouldn’t be called research, would it?”

Albert Einstein

Thank You