LECTURE 3

IV. RESEARCH METHODS AND TECHNIQUES

V. VARIOUS STAGES OF A RESEARCH

1. BASE TERMINOLOGY

Methodology - the **study of the methods** involved in some field, endeavor, or in problem solving

Method - a (systematic ?) codified **series of steps** taken to complete a certain task or to reach a certain objective

Methodology is defined as:

- "the analysis of the principles of methods, rules, and postulates employed by a discipline";
- "the systematic study of methods that are, can be, or have been applied within a discipline"; or
- "a particular procedure or set of procedures."

- a collection of theories, concepts or ideas
- comparative study of different approaches
- critique of the individual methods

Methodology refers to more than a simple set of methods;
it refers to the rationale and the philosophical assumptions that underlie a particular study.

In recent years *methodology* has been increasingly used as a pretentious substitute for *method* in scientific and technical contexts [Wikipedia]

Type	*Methods*	*Techniques*
1. Library Research	(i) Analysis of historical records	Recording of notes, Content analysis, Tape and Film listening and analysis.
	(ii) Analysis of documents	Statistical compilations and manipulations, reference and abstract guides, contents analysis.
2. Field Research	(i) Non-participant direct observation	Observational behavioural scales, use of score cards, etc.
	(ii) Participant observation	Interactional recording, possible use of tape recorders, photographic techniques.
	(iii) Mass observation	Recording mass behaviour, interview using independent observers in public places.
	(iv) Mail questionnaire	Identification of social and economic background of respondents.
	(v) Opinionnaire	Use of attitude scales, projective techniques, use of sociometric scales.
	(vi) Personal interview	Interviewer uses a detailed schedule with open and closed questions.
	(vii) Focussed interview	Interviewer focuses attention upon a given experience and its effects.
	(viii) Group interview	Small groups of respondents are interviewed simultaneously.
	(ix) Telephone survey	Used as a survey technique for information and for discerning opinion; may also be used as a follow up of questionnaire.
	(x) Case study and life history	Cross-sectional collection of data for intensive analysis, longitudinal collection of data of intensive character.
3. Laboratory Research	Small group study of random behaviour, play and role analysis	Use of audio-visual recording devices, use of observers, etc.

Scientific methods RESEARCH:

1. General logical methods of knowledge
(Induction, deduction, analysis, synthesis, abstraction, modeling, analogies, generalization,)

2. Methods of scientific knowledge
(Theoretical and empirical methods RESEARCH)

Анализ – это расчленение целостного предмета на составляющие части (стороны, признаки, свойства или отношения) с целью их всестороннего изучения.

Синтез – это соединение ранее выделенных частей (сторон, признаков, свойств или отношений) предмета в единое целое.

Абстрагирование – это особый прием мышления, который заключается в отвлечении от ряда свойств и отношений изучаемого явления с одновременным выделением интересующих нас свойств и отношений.

Обобщение – это такой прием мышления, в результате которого устанавливаются общие свойства и признаки объектов.

Индукцией называется такой метод исследования и способ рас- суждения, в котором общий вывод строится на основе частных посылок.

Дедукция – это способ рассуждения, посредством которого из общих посылок с необходимостью следует заключение частного характера.

Аналогия – это такой прием познания, при котором на основе сходства объектов в одних признаках заключают об их сходстве и в других признаках.

Моделирование – это изучение объекта (оригинала) путем создания и исследования его копии (модели), замещающей оригинал с определенных сторон, интересующих познание.

STAGES OF A RESEARCH ARE THE FOLLOWING

1. Selection of a research topic
2. Definition of a research problem
3. Literature survey and reference collection
4. Assessment of current status of the topic chosen
5. Formulation of hypotheses
6. Research design
7. Actual investigation
8. Data analysis
9. Interpretation of result
10. Report

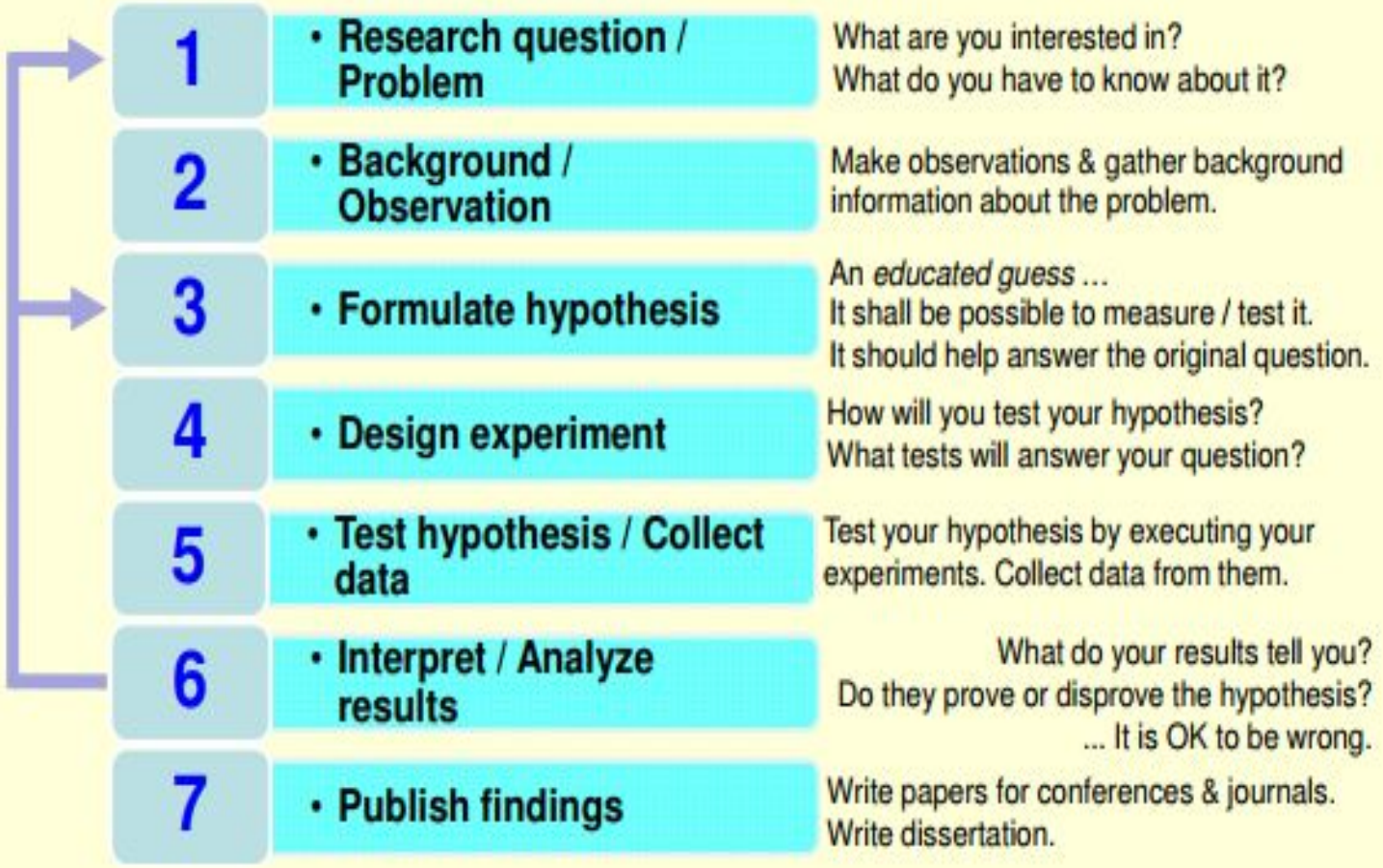
OR

Some of the important parts of a good quantitative or qualitative research proposal include:

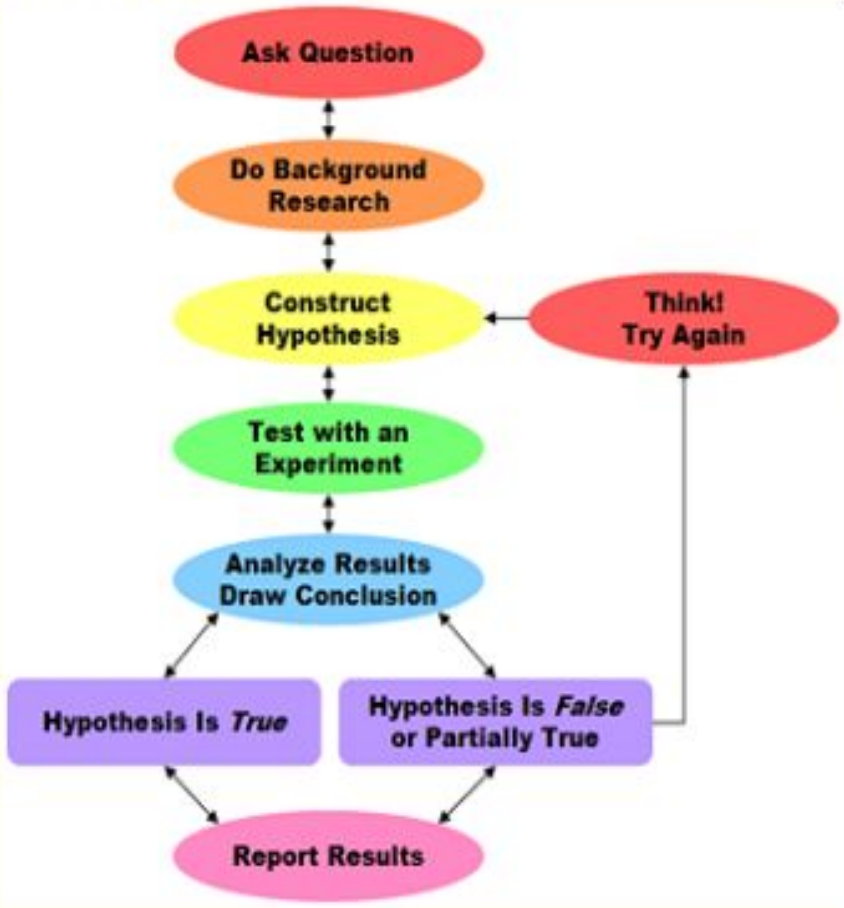
- Determining the general topic;
- Performing a Literature review on the topic;
- Identifying a gap in the literature;
- Identifying a problem highlighted by the gap in the literature and framing a purpose for the study;
- Writing an Introduction to the study;
- Framing research hypotheses and or research questions to investigate or guide the study;
- Determine the method of investigation
- Outline the research design
- Define the Sample size and the characteristics of the proposed sample;
- Describe the procedures to follow for data collection and data analyses.

Classical phases

Classical phases ...



Other variants



www.sciencebuddies.org/mentoring/project_scientific_method.shtml

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]

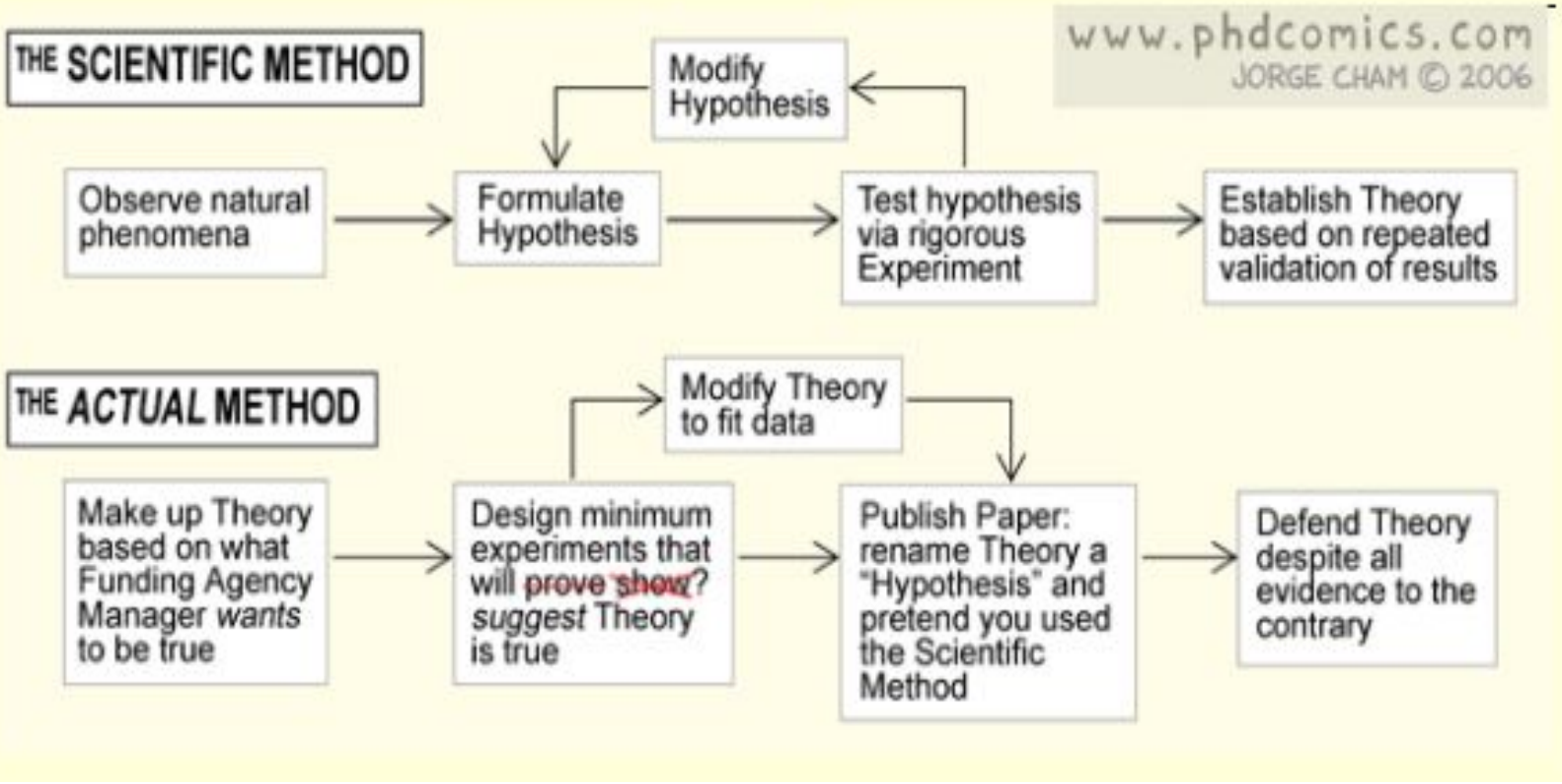
Other variants

1. **Observe** an event.
2. Develop a **model** (or **hypothesis**) which makes a **prediction**.
3. **Test** the prediction.
4. **Observe** the result.
5. **Revise** the hypothesis.
6. **Repeat** as needed.
7. A successful hypothesis becomes a **Scientific Theory**.

Ask Fred To Act Dramatically Cool

- **A- ask**
- **F- form a hypothesis**
- **T- test hypothesis**
- **A- analyze the results**
- **D- draw conclusions**
- **C- community**

In practice !

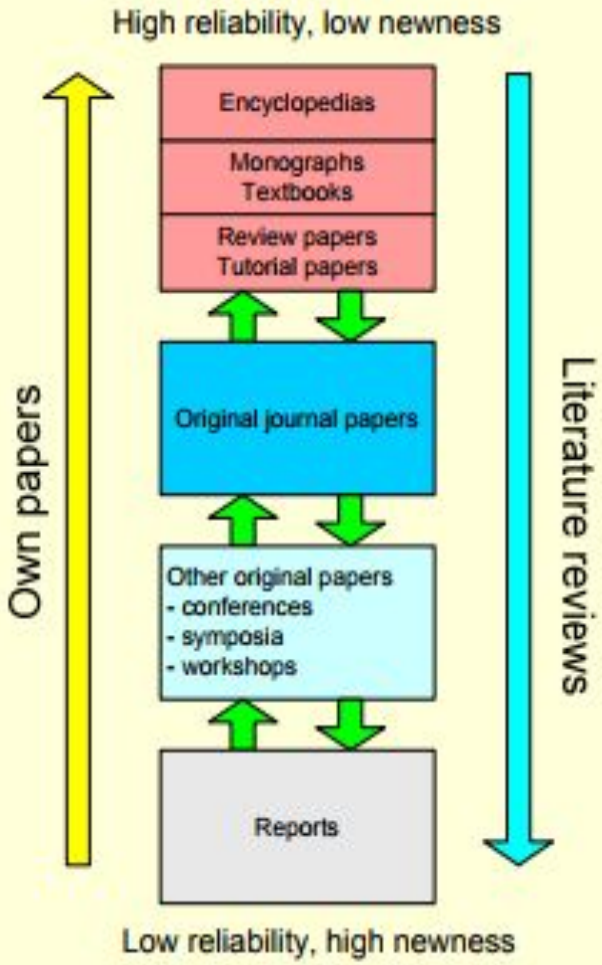

THE SCIENTIFIC METHOD
Modify Hypothesis
Observe natural phenomena
Formulate Hypothesis
Test hypothesis via rigorous Experiment
Establish Theory based on repeated validation of results
www.phdcomics.com
JORGE CHAM © 2006
THE ACTUAL METHOD
Modify Theory to fit data
Make up Theory based on what Funding Agency Manager wants to be true
Design minimum experiments that will prove show? suggest Theory is true
Publish Paper: rename Theory a "Hypothesis" and pretend you used the Scientific Method
Defend Theory despite all evidence to the contrary

Step 1: Formulate Research question / Problem

- The most important step in research !
- Often comes from the thought:
  "What we have now is not quite right/good enough – we can do better ..."
- The research question defines the "area of interest" but it is not a declarative statement like a hypothesis.
  The central research question may be complemented by a few secondary questions to narrow the focus.
- Research question must be capable of being confirmed or refuted.
- The study must be feasible.

Step 2: Background / Observation

- How has the work been done previously? What similar work has been leading up to this point?
  - Study state of the art (literature review, projects, informal discussions, etc).
  - Optional realization of preliminary experiments.
- What distinguishes previous work from what you want to do?
- Who / What will be impacted by this research?



You may iterate between Step 2 and Step 1!

Step 3: Formulate hypothesis

- A scientific hypothesis states the 'predicted' (educated guess) relationship amongst variables.

- Serve to bring clarity, specificity and focus to a research problem
  - ... But are not essential
  - ... You can conduct valid research without constructing a hypothesis
  - ... On the other hand you can construct as many hypothesis as appropriate

- Stated in declara **Step 3: Formulate hypothesis**

- A possible format (formalized):

  "If ..... then .... (because ....) "

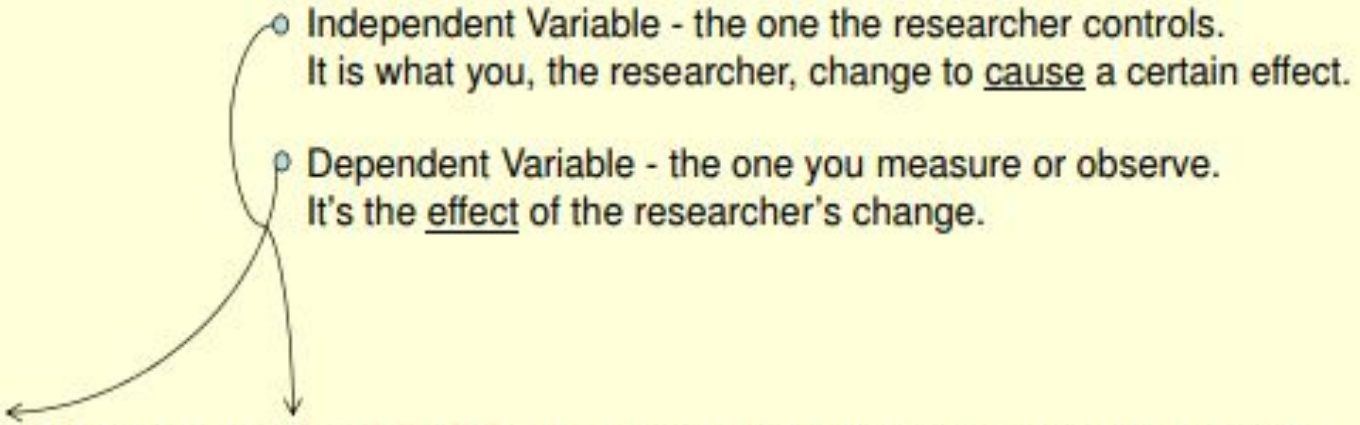
- In the case of a PhD dissertation, one hypothesis after tested becomes a thesis being defended.
  - One dissertation may include more than one thesis.
  - Sometimes people refer to the dissertation as the "thesis".

Characteristics of a hypothesis

- Should be simple, specific and conceptually clear.
  ... ambiguity would make verification almost impossible.
- Should be capable of verification.
  ... i.e. There are methods and techniques for data collection and analysis.
- Should be related to the existing body of knowledge.
  ... i.e. Able to add to the existing knowledge.
- Should be operationalisable
  ... i.e. Expressed in terms that can be measured.

Hypothesis – independent & dependent variables

The hypothesis shall contain two types of variables:
Independent Variable(s)
and
Dependent Variable(s)



"If skin cancer is related to ultraviolet light, then people with a high exposure to UV light will have a higher frequency of skin cancer."

"If temperature affects leaf color change, then exposing the plant to low temperatures will result in changes in leaf color."

Step 4: Design experiment

- Includes planning in detail all the steps of the experimental phase. In engineering research it often includes the design of a prototype / system architecture.
- Identify the variables that will be manipulated and measured – the research outcomes must be measurable.
  In other words:
  What needs to be controlled in order to get an umbiased answer to the research question.
- Therefore: it is necessary to <u>not only</u> design a prototype / system but also the thesis validation method !
  How to validate the thesis?
- The plan should allow others to repeat it. It should be feasible...!
- Plan intermmediate milestones.

If you fail to plan, you planned to fail !

"All sciences are vain and full of errors that are not born of experience, Mother of all certainty, and that are not tested by experience...."

Leonardo da Vinci

Step 5: Test hypothesis / Collect data

- Doing it !
- Implementation of methods (e.g. prototyping) and auxiliary tools (e.g. simulation)
- Pilot testing and refinement.
- Field vs. Laboratory work.
- Any ethical considerations ?
- Confirm results by retesting !

Test hypothesis – perform experiments

Step 6: Interpret / Analyze results

- What did your experiment show?

- Qualitative data analysis.
- Quantitative data analysis.
  - Descriptive and inferential statistics, clustering, ...

- What might weaken your confidence in the results (critical spirit)?

- Discussion regarding
  - Literature
  - Research objectives
  - Research questions.

- Consider next steps
  - Recommendations for further research.

Interpret / Analyze results

Young or old lady?

Consider multiple perspectives !

HINT: Use the girls face as the old woman's nose.

Step 7: Publish findings

- A research result is not a contribution to the field if no one knows about it or can use it !
- Write scientific papers, make presentations
  - Intermediate results
    - Conferences
    - Collect feedback
  - Consolidated results
    - Journals
  - Be careful in selecting where you publish !
- Write dissertation

"Publish or perish !"

Attributes of a good thesis

- It should be contestable, proposing an arguable point with which people could reasonably disagree.
  A strong thesis is provocative;
  it takes a stand and justifies the discussion you will present.
- It is specific and focused.
  A strong thesis proves a point without discussing "everything about …"
  Instead of music, think "American jazz in the 1930s" and your argument about it.
- It clearly asserts your own conclusion based on evidence.
  Note: Be flexible. The evidence may lead you to a conclusion you didn't think you'd reach. It is perfectly OK to change your thesis!
- It provides the reader with a map to guide him/her through your work.
- It anticipates and refutes the counter-arguments
- It avoids vague language (like "it seems").
- It avoids the first person. ("I believe," "In my opinion")
- It should pass the "So what? or Who cares?" test
  (Would your most honest friend ask why he should care or respond with "but everyone knows that"?)
  For instance, "people should avoid driving under the influence of alcohol",
  would be unlikely to evoke any opposition.

http://www.sdst.org/shs/library/thesis.html

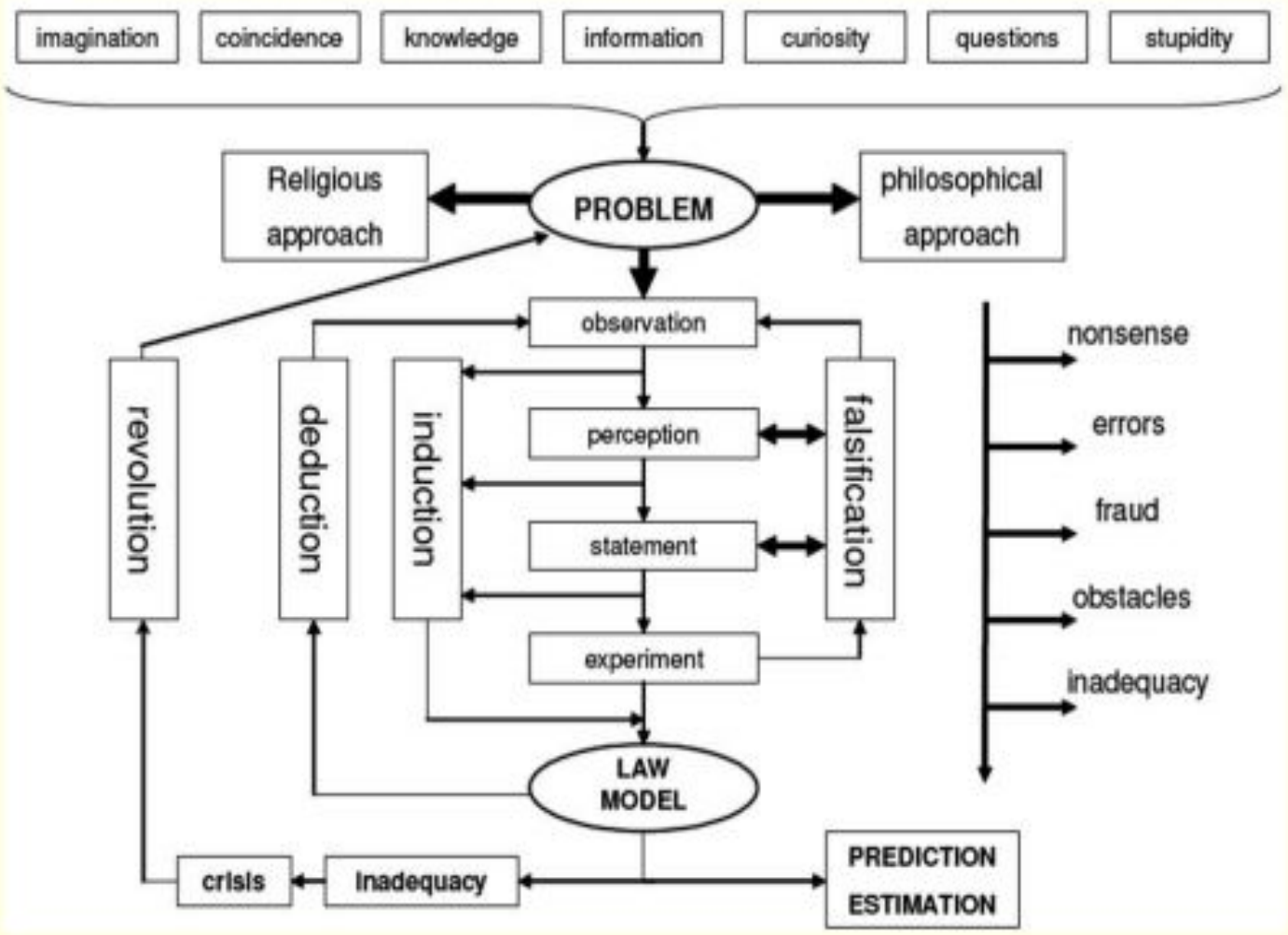
Scientist vs Engineer

- A scientist sees a phenomenon and asks "why?" and proceeds to research the answer to the question.

- An engineer sees a practical problem and wants to know "how" to solve it and "how" to implement that solution, or "how" to do it better if a solution exists.

- A scientist builds in order to learn, but an engineer learns in order to build.

Research methods in engineering



Research methods in engineering ...