Academic Paper Writing

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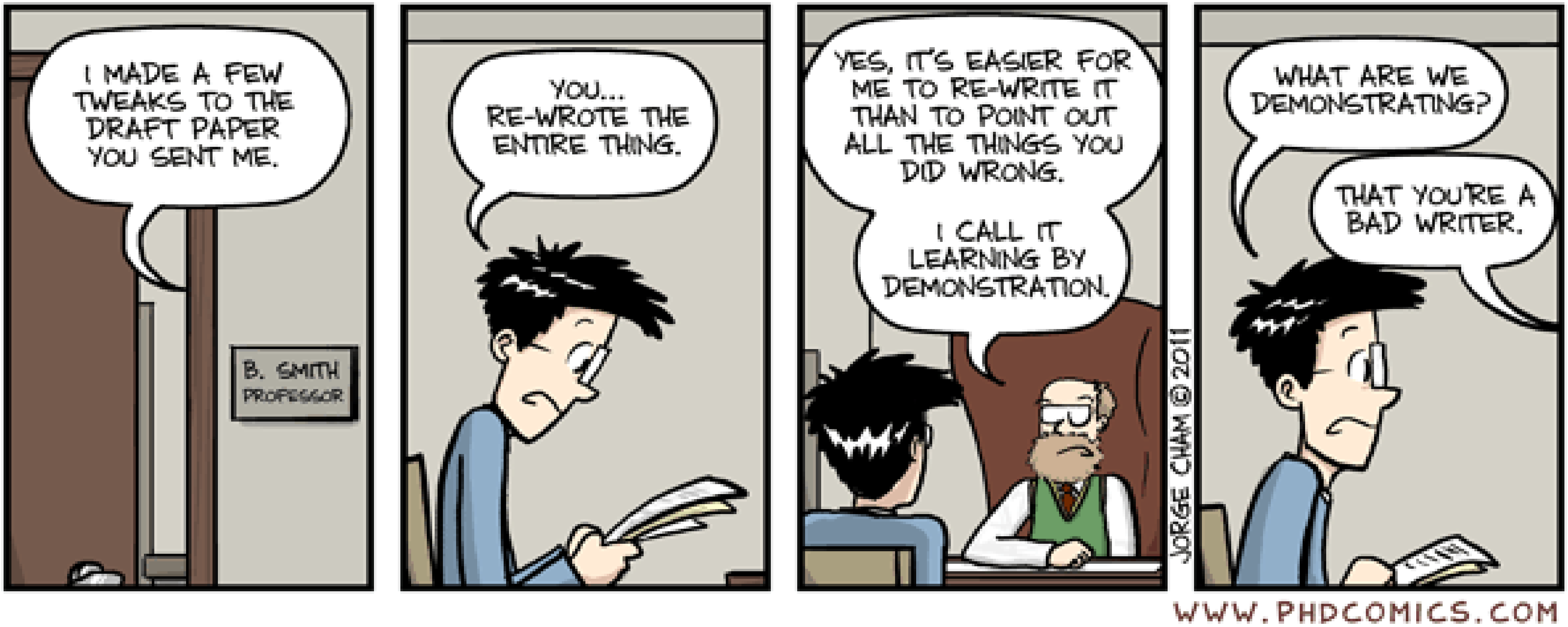
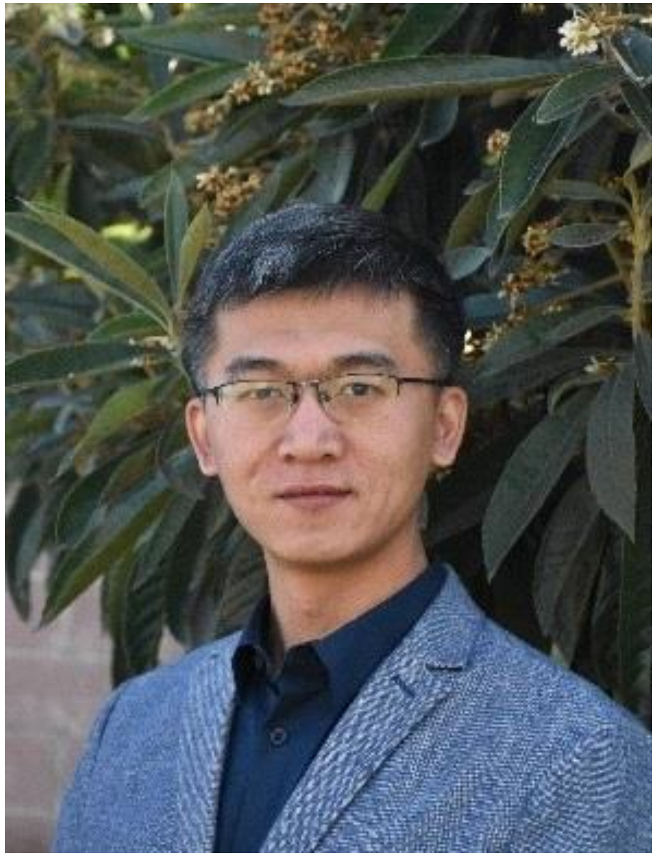
Have you ever experienced this?



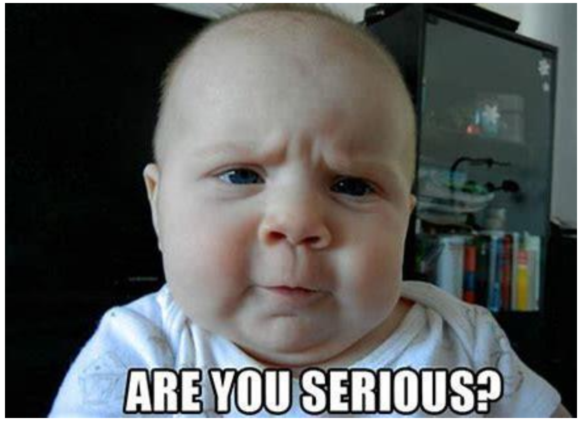
Instructor Information – Selected Publications

1. **Song LIU**, You-Fu Li and Xuewei Wang, “A Novel Dual-Probe based Micro-Grasping System Allowing Dexterous 3D Orientation Adjustment”, **IEEE Transactions on Automation Science and Engineering**, In Press.
2. **Song LIU**, You-Fu Li, and Dengpeng Xing, “Sensing and Control for Simultaneous Precision Peg-in-Hole Assembly of Multiple Objects”, **IEEE Transactions on Automation Science and Engineering**, vol. 17, no. 1, pp. 310-324, 2020.
3. **Song LIU**, and You-Fu Li, “A High Precision Automatic Wire Wrapping Approach Based on Microscopic Vision and Force Information”, **IEEE Transactions on Industrial Informatics**, vol. 16, no. 1, pp. 161-170, 2020.
4. **Song LIU**, Dengpeng Xing, You-Fu Li, Jianwei Zhang, and De Xu, “Robust Insertion Control for Precision Assembly with Passive Compliance Combining Vision and Force Information”, IEEE/ASME Transactions on Mechatronics, vol. 24, no. 5, pp. 1974-1985, 2019.
5. **Song LIU**, and You-Fu Li, “Precision 3D Motion Tracking for Binocular Microscopic Vision System”, **IEEE Transactions on Industrial Electronics**, vol. 64, no. 12, pp. 9339-9349, 2019.
6. **Song LIU**, You-Fu Li, De Xu, Dengpeng Xing and Hu Su, “An Efficient Insertion Control Method for Precision Assembly of Cylindrical Components”, **IEEE Transactions on Industrial Electronics**, vol. 64, no. 12, pp. 9355-9365, 2017.
7. **Song LIU**, De Xu, You-Fu Li and Fei Shen, “Nano Liter Fluid Dispensing Based on Microscopic Vision and Laser Range Sensor”, IEEE Transactions on Industrial Electronics, vol. 64, no. 2, pp. 1292-1302, 2017.
8. **Song LIU**, De Xu, Fangfang Liu, Dapeng Zhang and Zhengtao Zhang, “Relative Pose Estimation for Alignment of Long Cylindrical Components Based on Microscopic Vision”, **IEEE/ASME Transactions on Mechatronics**, vol. 21, no. 3, pp. 1388-1398, 2016.
9. **Song LIU**, De Xu, Dapeng Zhang and Zhengtao Zhang, “High Precision Automatic Assembly Based on Microscopic Vision and Force Information”, **IEEE Transactions on Automation Science and Engineering**, vol. 13, no. 1, pp. 382–393, 2016.
10. Hai Liu, **Song LIU** (Co-first Author), and Eun Sok Kim, “Active Noise Cancellation with MEMS Resonant Microphone Array”, **IEEE Journal of Microelectromechanical Systems** (JMEMS), accepted.



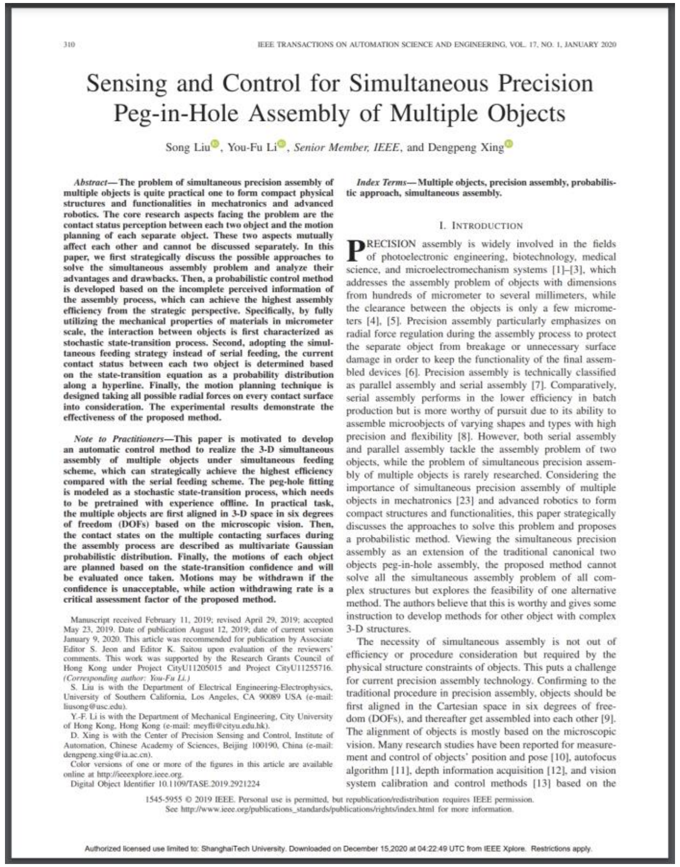
Dr. Song LIU

Evaluation



- **Class Participation 15%** + **Post 35%** + **Academic Paper 50%**
- The materials from which the students are requested to **write the academic paper** are from **doctoral theses** dedicatedly selected by the SIST professors from the outstanding ones nationwide in China. The **three** theses correspond to CS, EE and IE respectively. Students are expected to make a choice by their major.
- The **post**, as an essential and regular part for communication in an international conference, is designed to briefly describe the academic paper written. With the support from the school level and TAs, the course will hold a **seminar** for the **last three weeks** of the semester for oral communication with others. TAs and SIST professors will go through students' posts, ask questions, raise comments, and finally score the post.
- The paper and post are both requested to be written **in English**. The paper is requested to follow **IEEE Transactions journal template** (6 pages paper length) without limitations on writing tool, like Microsoft Word or Latex (including Overleaf powered by Latex Engine).

Evaluation



310 IEEE TRANSACTIONS ON AUTOMATION SCIENCE AND ENGINEERING, VOL. 17, NO. 1, JANUARY 2020

Sensing and Control for Simultaneous Precision Peg-in-Hole Assembly of Multiple Objects

Song Liu, You-Fu Li, *Senior Member, IEEE*, and Dengpeng Xing

***Abstract*—The problem of simultaneous precision assembly of multiple objects is quite practical one to form compact physical structures and functionalities in mechatronics and advanced robotics. The core research aspects facing the problem are the contact status perception between each two object and the motion planning of each separate object. These two aspects mutually affect each other and cannot be discussed separately. In this paper, we first strategically discuss the possible approaches to solve the simultaneous assembly problem and analyze their advantages and drawbacks. Then, a probabilistic control method is developed based on the incomplete perceived information of the assembly process, which can achieve the highest assembly efficiency from the strategic perspective. Specifically, by fully utilizing the mechanical properties of materials in micrometer scale, the interaction between objects is first characterized as stochastic state-transition process. Second, adopting the simultaneous feeding strategy instead of serial feeding, the current contact status between each two object is determined based on the state-transition equation as a probability distribution along a hyperline. Finally, the motion planning technique is designed taking all possible radial forces on every contact surface into consideration. The experimental results demonstrate the effectiveness of the proposed method.**

***Note to Practitioners*—This paper is motivated to develop an automatic control method to realize the 3-D simultaneous assembly of multiple objects under simultaneous feeding scheme, which can strategically achieve the highest efficiency compared with the serial feeding scheme. The peg-hole fitting is modeled as a stochastic state-transition process, which needs to be pretrained with experience offline. In practical task, the multiple objects are first aligned in 3-D space in six degrees of freedom (DOFs) based on the microscopic vision. Then, the contact states on the multiple contacting surfaces during the assembly process are described as multivariate Gaussian probabilistic distribution. Finally, the motions of each object are planned based on the state-transition confidence and will be evaluated once taken. Motions may be withdrawn if the confidence is unacceptable, while action withdrawing rate is a critical assessment factor of the proposed method.**

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Color versions of one or more of the figures in this article are available online at http://ieeexplore.ieee.org.

Digital Object Identifier 10.1109/TASE.2019.2921224

***Index Terms*—Multiple objects, precision assembly, probabilistic approach, simultaneous assembly.**

I. INTRODUCTION

PRECISION assembly is widely involved in the fields of photoelectronic engineering, biotechnology, medical science, and microelectromechanism systems [1]–[3], which addresses the assembly problem of objects with dimensions from hundreds of micrometer to several millimeters, while the clearance between the objects is only a few micrometers [4], [5]. Precision assembly particularly emphasizes on radial force regulation during the assembly process to protect the separate object from breakage or unnecessary surface damage in order to keep the functionality of the final assembled devices [6]. Precision assembly is technically classified as parallel assembly and serial assembly [7]. Comparatively, serial assembly performs in the lower efficiency in batch production but is more worthy of pursuit due to its ability to assemble microobjects of varying shapes and types with high precision and flexibility [8]. However, both serial assembly and parallel assembly tackle the assembly problem of two objects, while the problem of simultaneous precision assembly of multiple objects is rarely researched. Considering the importance of simultaneous precision assembly of multiple objects in mechatronics [23] and advanced robotics to form compact structures and functionalities, this paper strategically discusses the approaches to solve this problem and proposes a probabilistic method. Viewing the simultaneous precision assembly as an extension of the traditional canonical two objects peg-in-hole assembly, the proposed method cannot solve all the simultaneous assembly problem of all complex structures but explores the feasibility of one alternative method. The authors believe that this is worthy and gives some instruction to develop methods for other object with complex 3-D structures.

The necessity of simultaneous assembly is not out of efficiency or procedure consideration but required by the physical structure constraints of objects. This puts a challenge for current precision assembly technology. Confirming to the traditional procedure in precision assembly, objects should be first aligned in the Cartesian space in six degrees of freedom (DOFs), and thereafter get assembled into each other [9]. The alignment of objects is mostly based on the microscopic vision. Many research studies have been reported for measurement and control of objects' position and pose [10], autofocus algorithm [11], depth information acquisition [12], and vision system calibration and control methods [13] based on the

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Paper

Post

You are highly encouraged to answer my questions or interact with me on class so that I can give a bonus to your final grade as part of your class participation score.

Why Academic Paper Writing? – The Big Reason

- Good scientific writing is not a matter of life and death; It is much more serious than that – Robert A. Day
- **The goal of scientific research is publication**. (Never Doubt this)
  - ➢A scientific experiment, now matter how spectacular the results, is not completed until the results are published.
  - ➢Actually, the cornerstone of the philosophy of science is based on the fundamental assumption that original research must be published.
  - ➢Only thus can new scientific knowledge be authenticated and then added to the existing database that we call scientific knowledge.
  - ➢Publications are the best medium for communication in academia.

You, as a graduate student, are contributing to mankind civilization!

Why Academic Paper Writing? – Career Reason

- Scientists, starting as graduate students, are measured primarily not by their dexterity in lab, not by their innate knowledge of either broad or narrow scientific subjects, and certainly not by their wit or charm; they are measured and become known by their publications.
- Publications are the best way to persuade employers to put a big offer on the table for you. (This is what my experience told me)
- With publications, you never need a resume!

Why Academic Paper Writing? – Personal

- Scientific writing is all about critical thinking.
- Critical thinking is the most import skill for a man to succeed in whatever field.
- Academic training is actually about critical thinking training.

You really know how to think?

Why Academic Paper Writing? – Personal

- Scientific writing is all about **critical thinking**.
- Critical thinking is the most import skill for a man to succeed in whatever field.
- Academic training is actually about critical thinking training.

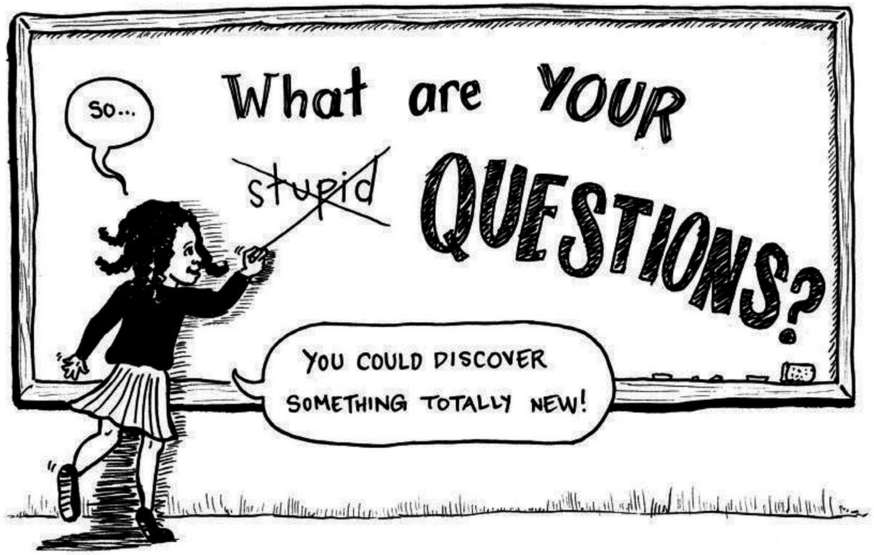
You really know how to think?

One of the most humiliating and disappointing comments in mankind history for a paper review

I don’t know what this paper is talking about?

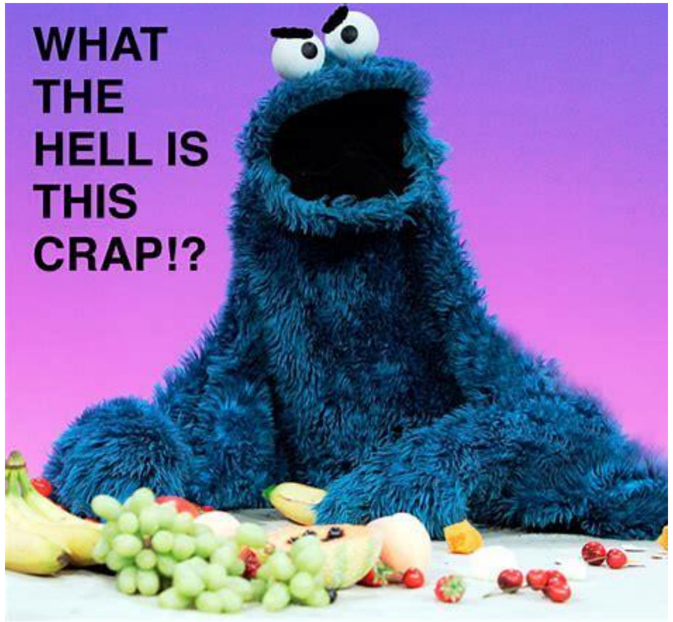
What is Academic Paper Writing?

- The term **scientific writing** commonly denotes the reporting of **original research** in journals, through scientific **papers**, **in standard format**.
- Academic paper **a document** showing **what** he or she did, **why** is was done, **how** it was done, and **what** was learned from it.
- The keyword is reproductivity.



Academic Paper Writing-what to learn?

- Research topic selecting NO
- Sentence phrasing or language polishing NO
- Writing tools techniques, like Microsoft Word of Latex NO
- Results illustration techniques A little
- Formatting techniques No
- Literature review techniques Maybe



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Techniques is not the focus of this course, because there is no paper writing techniques you can learn from a class without practicing.

Academic Paper Writing-what to learn?

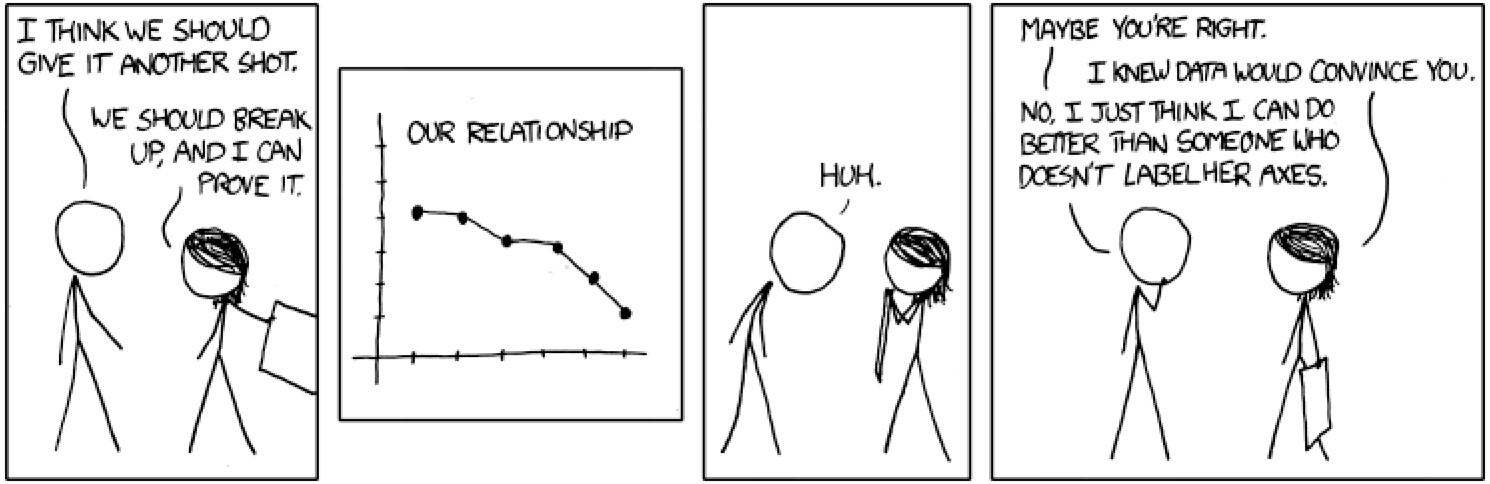
- This course tells you more than that, and more interesting!!!
  - ➢ The review process?
  - ➢ How the reviewers review your papers?
  - ➢ What is the most important part of an academic paper?
  - ➢ What you should do first when receive the reviewers' comments?
  - ➢ Do you need to satisfy all what the reviewers ask for?
  - ➢ What are the reviewers talking about?
  - ➢ What are the reviewers thinking about?
  - ➢ Even, can we classify reviewers?

With good understanding of these questions, you will have a good perception of how to write and what is an excellent academic paper.

Research Methodologies

Basic Concepts and Methods

By Dr. Song LIU



Learning Objectives

- Define and explain the concept of scientific research, deduction and induction reasoning, theory, hypothesis and empiricism.
- Clarify the Sources of knowledge/truth
- Identify and explain the features and application of different categories and sub-categories of research methods
- Characteristics of good topic
- Steps in conducting a research
- Application and exercises (identification of the research type).

Basic Concepts and Terms

Basic Concepts and Terms

- **Definition of Scientific Research**

➢ Scientific Research can be defined as a **systematic**, **controlled**, **empirical**, and **critical investigation** of **hypothetical propositions** about the presumed relations among observed phenomena.

Approaches to Knowledge

- **Five sources of evidence in the pursuit of truth**

➢1. Authority
➢2. Custom and tradition
➢3. Personal experience
➢4. Deductive reasoning & inductive reasoning
➢5. Scientific inquiry

Deductive vs Inductive Reasoning

Deductive Reasoning

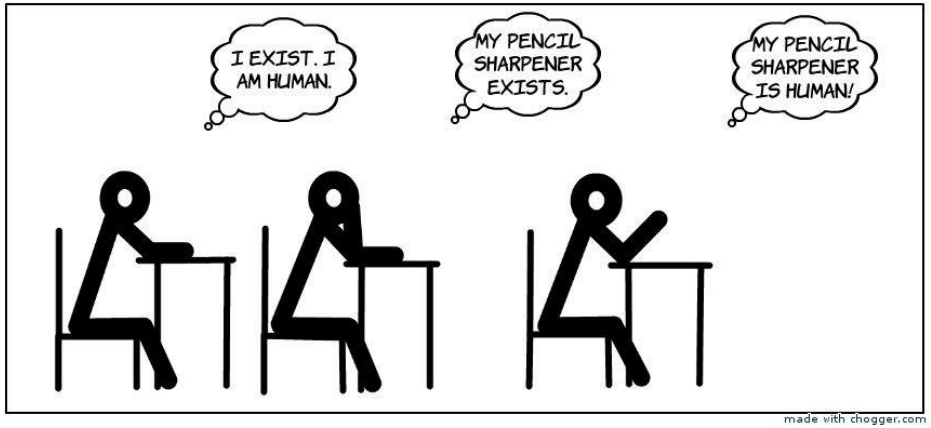
- Thinking proceeds from general assumption to specific application.

A General -> Specific Process

Inductive Reasoning

- Conclusions about events (general) are based on information generated through many individual and direct observations (specific).

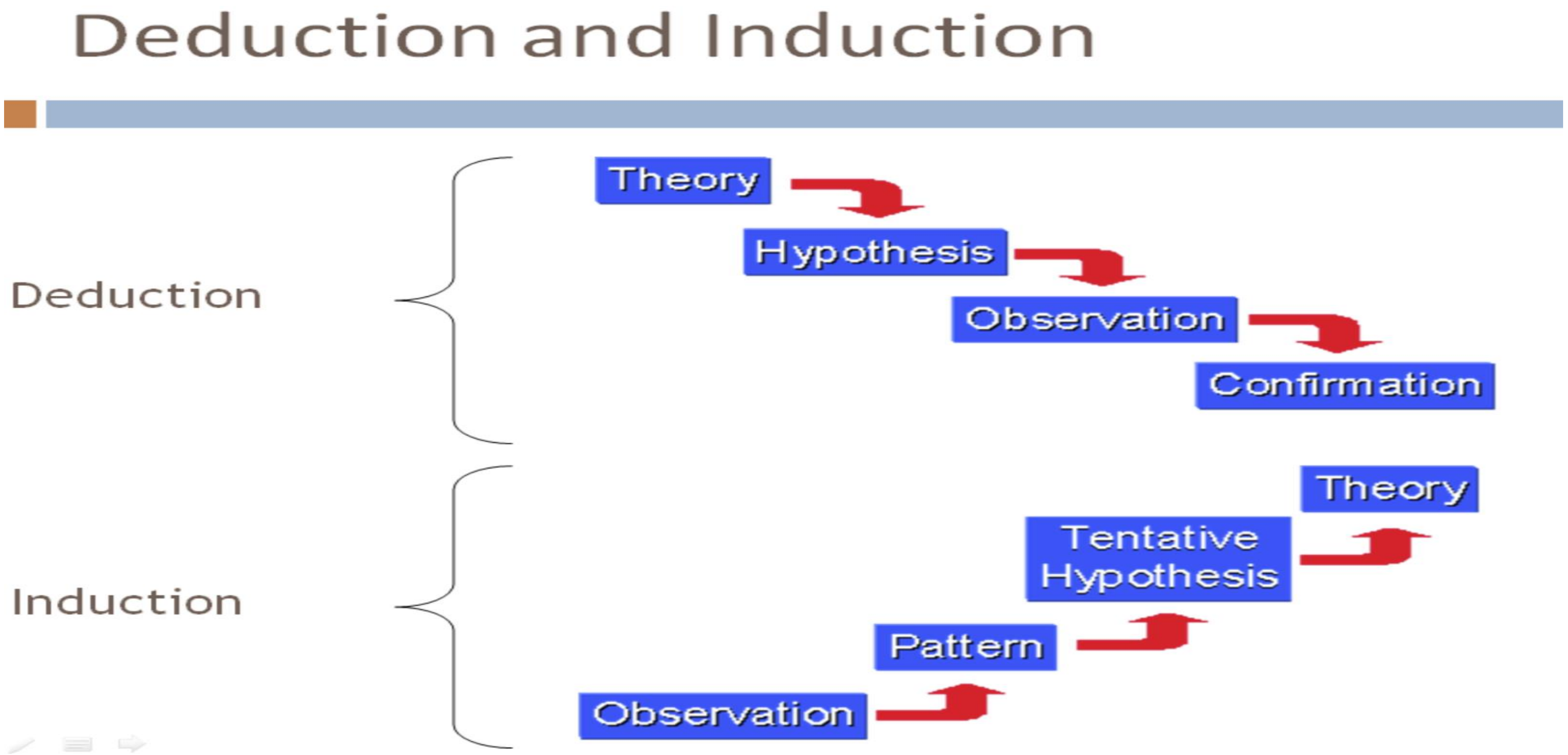
Specific -> General Process



Deductive vs Inductive Reasoning

- **Deductive:**
  - **Every mammal has lungs. All rabbits are mammals. Therefore, every rabbit has lungs.**
- **Inductive:**
  - **Every rabbit that has been observed has lungs. Therefore, every rabbit has lungs.**

Deductive vs Inductive Reasoning



About Logic Reasoning

- Sometimes we acquire knowledge through the use of **logic**. Here is an example of a logical deduction:

  All birds have feathers.

  This animal has feathers.

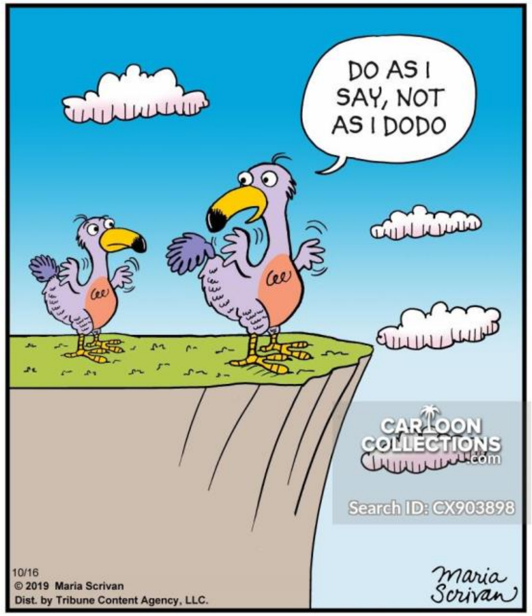
  Therefore, this animal is a bird.

- Many times, as in the case above, logic leads us to the truth. However, sometimes using logic alone leads us to incorrect conclusions. Consider the example below:

  (Almost) all birds can fly.

  This animal can fly.

  Therefore, this animal is a bird.

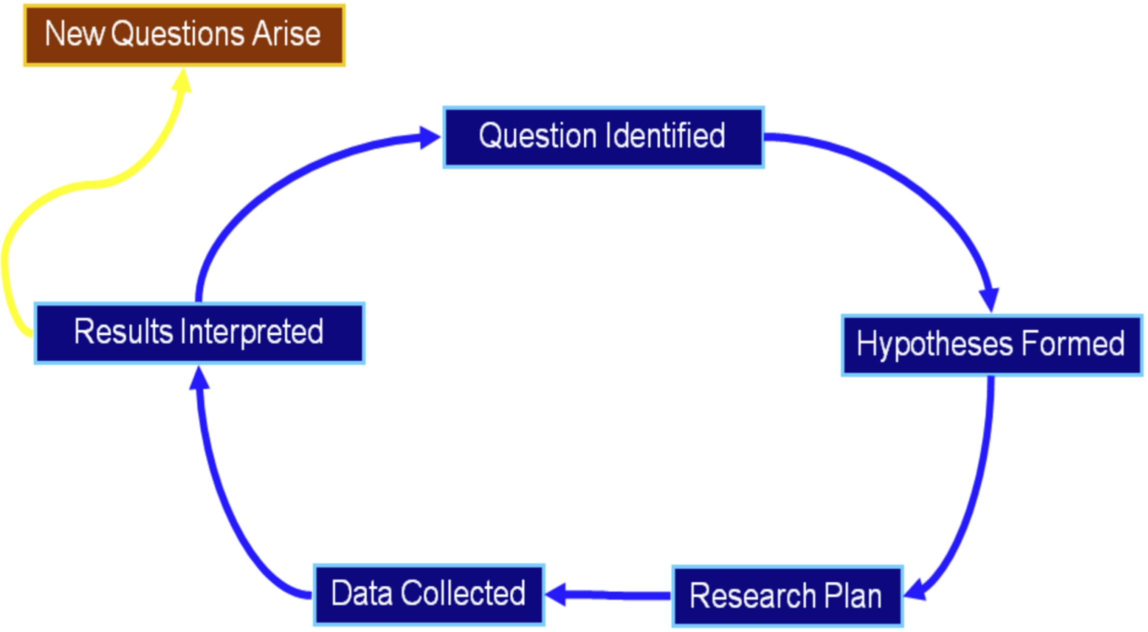


Logical Steps of Scientific Method

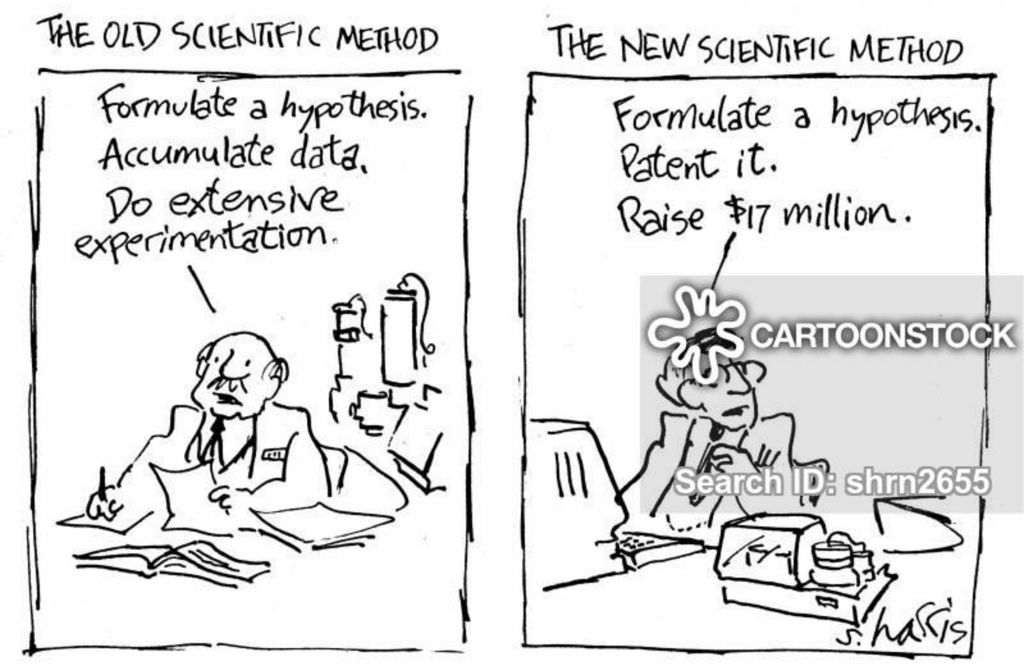
- Systematic and cyclic series of logical steps
  - Identifying the problem (mostly by another language, like Math)
  - Formulating a hypothesis (we discussed this just before)
  - Developing the research plan
  - Collecting and analyzing the data
  - Interpreting results and forming conclusions

KNOW HOW TO GO!

Logical Steps of Scientific Method



Closed-loop conceptualization of the research process (Drew, Hardman,

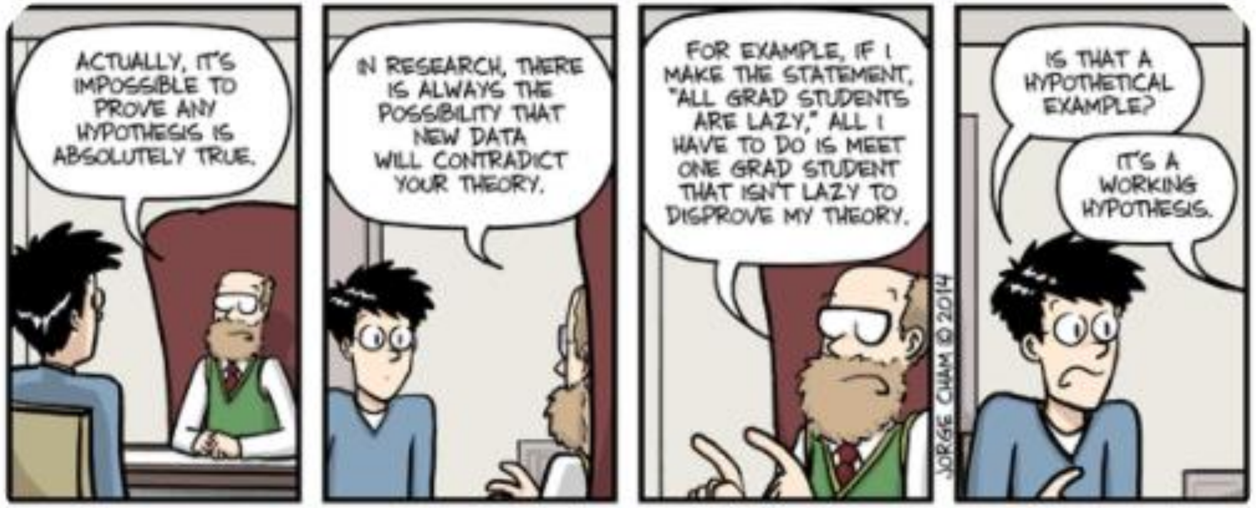


This is the typical routine that we go deeper and deeper to a research problem or research field, and finally to become a specialist or professional on that.

Theory vs Hypothesis

- Hypothesis
  - A belief or **prediction** of the final outcome of the research
  - A concrete, specific **statement** about the relationships between phenomena
  - Based on **deductive reasoning**

- Theory (A well developed and proved Hypo)
  - A belief or **assumption** about how things relate to each other
  - A theory **establishes a cause-and-effect relationship** between variables with a purpose of explaining and predicting phenomena
  - Based on **inductive reasoning**



In an ideal world…

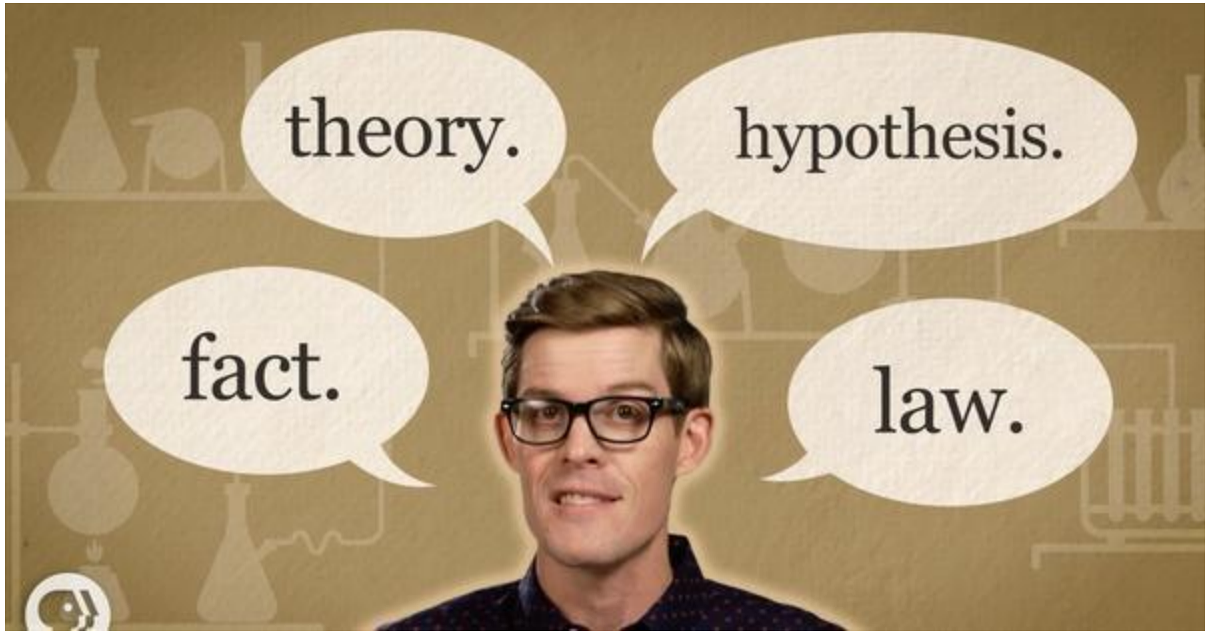
Hypotheses

↓

Theories

↓

Laws



Empiricism vs Pragmatic Observation

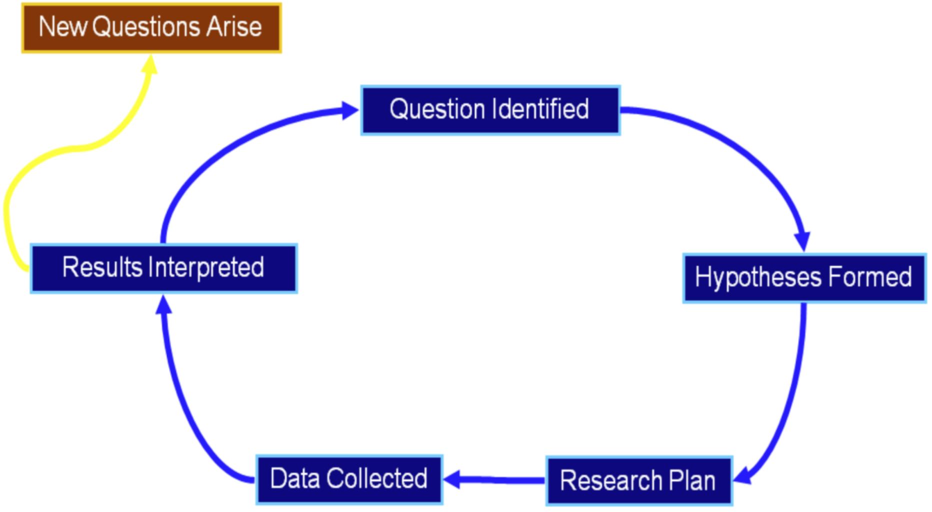
- Empiricism (we typically make hypothesis empirically)

➢ Acquiring information and facts through the observation of our world

- Pragmatic observations (This is how nowadays researcher do research)

➢ Developing theory through experience and observation

Types of Research



Closed-loop conceptualization of the research process (Drew, Hardman,

Research Classification

- **System #1: (Application of Research Study)**

– Basic research
– Applied research

- **System #2: (Research Objective)**

– Quantitative research (Physics, or Engineering Research)
– Qualitative research (Psychology, Journalism Research)

- **System #3: (Inquiry Mode Employed)**

– Experimental research
– Nonexperimental research

Research Classification

1. Application of research study
- pure research
- applied research

2. Objectives in undertaking the research
-descriptive
-correlational
-explanatory
-exploratory

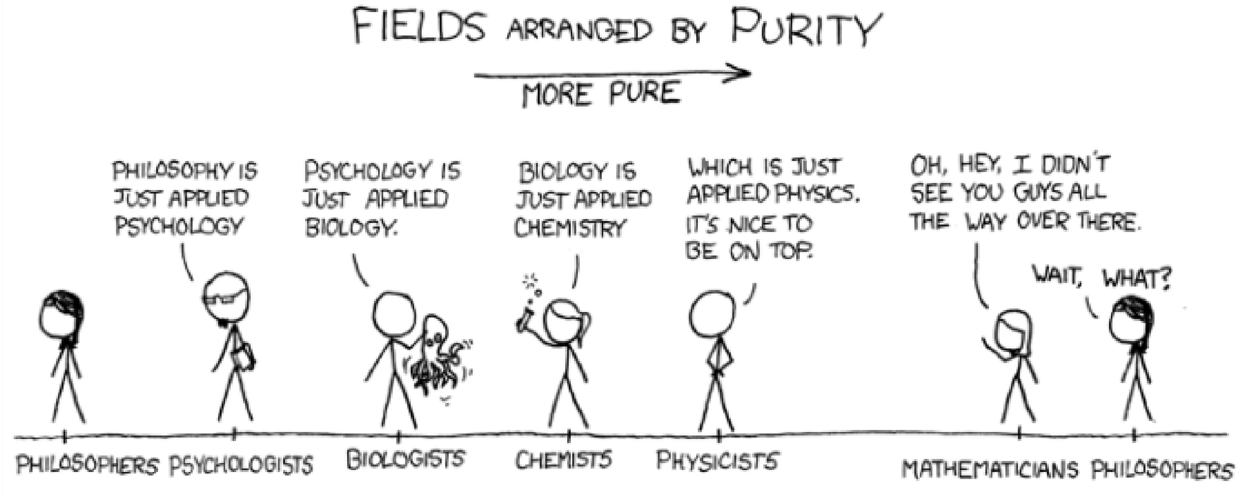
3. Inquiry mode employed
- Structured approach
- Unstructured approach

#1 Application of Research Study

From the point of view of application, there are two broad categories of research: Pure & Applied Research.

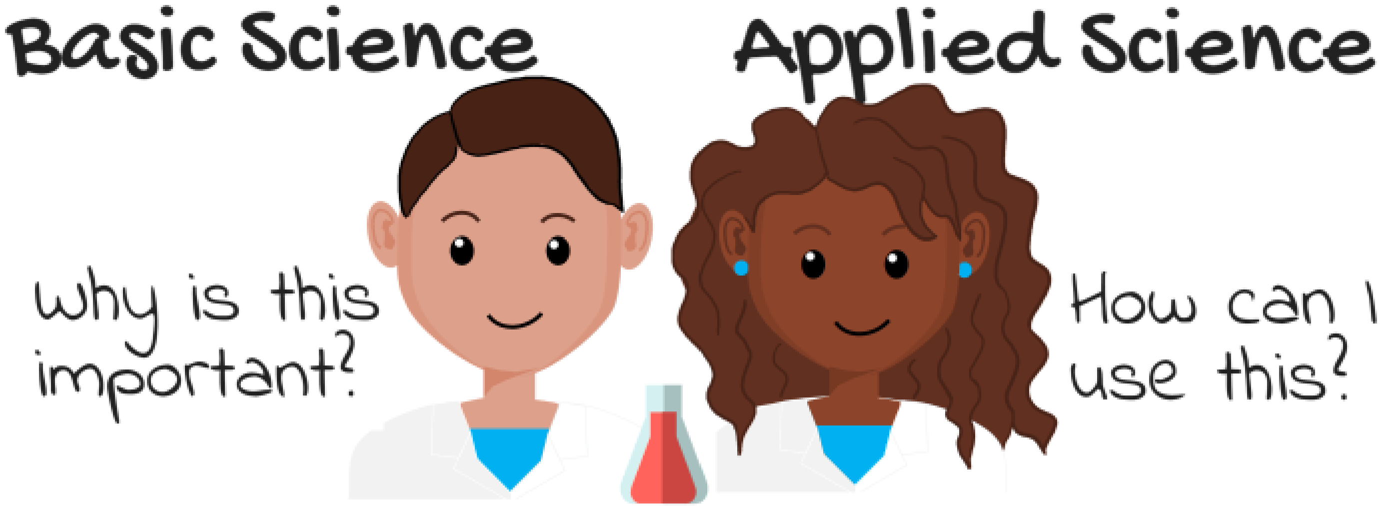
Pure/ Basic research:

Involves developing and testing theories and hypotheses that are intellectually challenging to the researcher but may or may not have practical application at the present time or in the future. The knowledge produced through pure research is sought in order to add to the existing body of research methods.



Applied Research

- Applied Research is done to solve specific, practical questions; for policy formulation, administration and understanding of a phenomenon. It can be exploratory, but is usually descriptive. It is almost always done **on the basis of basic research**.



Applied Research vs Basic Research

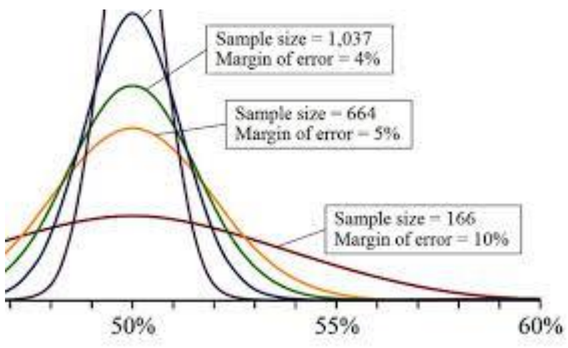
- Basic
  - Pure, fundamental research
  - Discovery of new knowledge; theoretical in nature
  - Takes many years for the results of basic research to find some practical utility
- Applied
  - Central purpose to solve an immediate problem
  - Improved products or processes
  - Infers beyond the group or situation studied
  - Interpretation of results relies upon Basic research

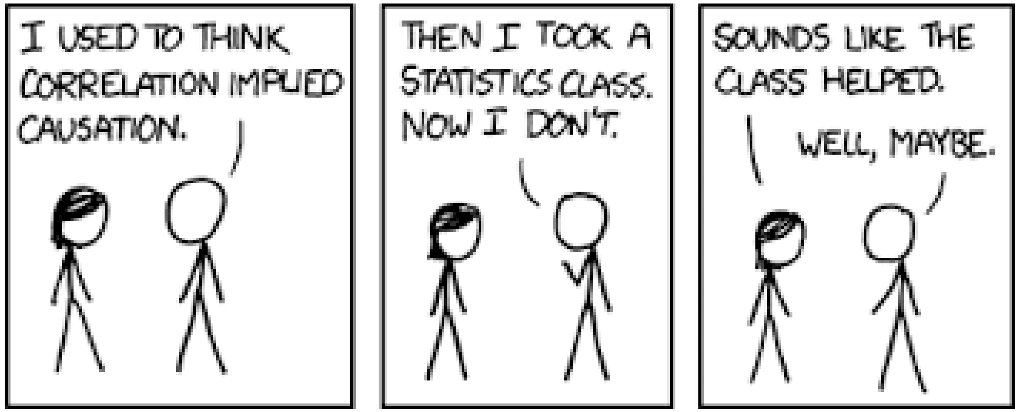
#2 Objectives of Research

- a – Descriptive
- b – Correlational
- c - Explanatory

#2 Objectives – Descriptive Research

- Descriptive research attempts to describe systematically a situation, problem, phenomenon, service or programme, or provides information about, say, living condition of a community, or describes attitudes towards an issue.
- Descriptive research refers to research that provides an accurate portrayal of characteristics of a particular individual, situation, or group.
- Descriptive research, also known as **statistical research**.





#2 Objectives – Descriptive Research

- Descriptive studies are a means of
  - discovering new meaning,
  - describing what exists,
  - determining the frequency with which something occurs, and categorizing information.

- **Descriptive research deals with everything that can be counted and studied, which has an impact of the lives of the people it deals with.**
  - For example, finding the most frequent disease that affects the children of a town. The reader of the research will know what to do to prevent that disease thus, more people will live a healthy life.

#2 Objectives – Descriptive Research

Advantages:

• The people individual studied are unaware so they act naturally or as they usually do in everyday situation;
• It is less expensive and time consuming than quantitative experiments;
• Collects a large amount of notes for detailed studying;
• As it is used to **describe and not make any conclusions.** it is to start the research with it;

Disadvantages

• Descriptive research requires more skills.
• **Does not identify cause** behind a phenomenon
• Response rate is low in this research.
• **Results of this research can change over the period of time.**

#2 Objectives – Correlational Research

Correlational research refers to the systematic investigation or statistical study of relationships among two or more variables, without necessarily determining cause and effect.

For example, to test the hypothesis " Listening to music lowers blood pressure levels" there are 2 ways of conducting research

- Experimental – group samples and make one group listen to music and then compare the Bp levels
- Survey – ask people how they feel ? How often they listen? And then compare

#2 Objectives – Correlational Research

Advantages:

1) Can collect much information from many subjects at one time.

2) Can study a wide range of variables and their interrelations.

3) Study variables that are not easily produced in the laboratory.

Disadvantages:

1. Correlation does not indicate causation(cause and effect).

#2 Objectives – Explanatory & Exploratory

Explanatory research attempts to clarify **why and how** there is a relationship between two or more aspects of a situation or phenomenon.

Exploratory research is undertaken to explore an area where **little** is known or to investigate the possibilities of undertaking a particular research study (feasibility study / pilot study).

In practice most studies are a combination of the first three categories .

Any example?

#3 Inquiry Model

a- Structured approach & b- Unstructured approach

a- **Structured approach:**

The structured approach to inquiry is usually classified as

-**Quantitative research**.

Here everything that forms the research process-objectives, design, sample, and the questions that you plan to ask of respondents- is predetermined. It is more appropriate to determine the extent of a problem, issue or phenomenon by **quantifying** the variation.

#3 Inquiry Model

a- Structured approach & b- Unstructured approach

b- **Unstructured approach:**

The unstructured approach to inquiry is usually classified as

-**Quantitative research**.

- This approach allows flexibility in all aspects of the research process.
- It is more appropriate to explore the nature of a problem, issue or phenomenon **without quantifying it**.
- Main objective is to **describe** the variation in a phenomenon, situation or attitude.
- **In many studies you have to combine both qualitative and quantitative approaches.**

#3 Inquiry Model

- Quantitative
  - Numerical, measurable data
  - Traditional or positivist approach
    - Clearly stated questions
    - Rational hypotheses
    - Developed research procedures
    - Extraneous variable controls
    - Large samples
    - Traditional, statistical analyses

- Qualitative
  - Generally non-numerical data
  - Typically anthropological and sociological research methods
  - Observations of a “natural” setting
  - In-depth descriptions of situations
  - Interpretive and descriptive

Common Approaches in Qualitative Research

1- Ethnography

- Ethnography: is an approach relying on the collection of data in the natural environment.
- Ethnographers are interested in how the behavior of individuals is influenced or mediated by culture in which they live.
- So, human behavior can only be understood if studied in the setting in which it occurs. As people can influence and be influenced by the groups they live in.
- The purpose of ethnographic research is to attempt to understand what is happening naturally in the setting and to interpret the data gathered to see what implications could be formed from the data.

2- Phenomenology Analysis

- Phenomenology: It focuses on individuals' interpretation of their experience and the ways in which they express them.
- The researchers task is to describe phenomena as experienced and expressed by individuals.
- Phenomenological research an inductive, descriptive research approach developed from phenomenological philosophy; its aim is to describe an experience as it is actually lived by the person

3- Discourse Analysis

- Discourse is a term used to describe the systems we use in communication with others. These include verbal, nonverbal and written material.
- What we say, how we say it, our choice of words, tone, timing are full of values, meanings and intentions.
- So, analysis of discourse increases our understanding of human behavior through language and interaction.

4- Grounded Research

- Theories arises from the data.
- GT is an inductive approach to research whereby hypotheses and theories emerge out or are grounded in data.
- GT research is a research approach designed to discover what problems exist in a given social environment and how the persons involved handle them; it involves formulation, testing, and reformulation of propositions until a theory is developed.

Common Approaches in Qualitative Research

- The 4 approaches of qualitive research are similar in that they place emphasis on interpretation rather than objective empirical observations.

- **Ethnography focuses on ....culture,**
- **Phenomenology on ....consciousness,**
- **Discourse analysis on.................. language and**
- **Ground theory's aim is the development of theory through induction.**

The Critique of Qualitative Research

- 1. Qualitative research is too subjective
- 2. Difficult to replicate
- 3. Problems of generalization
- 4. Lack of transparency

Experimental Research
vs.
Nonexperimental Research

Experimental Research

Experimental research is an objective, systematic, controlled investigation for the purpose of predicting and controlling phenomena and examining probability and causality among selected variables.

Advantages

- Best establishes cause-and-effect relationships

Disadvantages

- Feasibility
- Ethical Issues

Experimental Design

The simplest experimental design includes two variables and two groups of participants.

The two variables(IV &DV)

- The IV is the predictor variable whereas the DV is the outcome variable.
- Researchers manipulate and control the IV to study it's effect on the DV.

The two groups (Control versus Experimental group)

Experimental Design

- Before beginning the experiment, the researcher (randomly) assigns his/her sample to two different groups: the control group and the experimental (treatment group or clinical group).

- The control group receives no manipulation of the IV (no treatment), whereas the experimental group receives the manipulation of the IV

Experimental vs. Nonexperimental

- Experimental
  - IVs and DVs
  - Cause-and-effect
  - Extraneous variable controls
  - 3 fundamental characteristics
    1. At least 1 active IV
    2. Extraneous var controls
    3. Observation of the DV response to the IV

- Nonexperimental
  1. Causal-comparative
  2. Descriptive
  3. Correlational
  4. Historical

Experimental Design

- 1. Pre Experimental
- 2. Quasi Experimental
- 3. True Experimental

1. Pre-experimental Design

Pre-experimental designs are so named because they follow basic experimental steps but fail to include a control group. In other words, a single group is often studied but no comparison between an equivalent nontreatment group is made.

Examples include the following:

A.1- One Group Pretest Posttest Study

A.2-The One-Shot Case Study

A.1 The One-shot Case Study

In this arrangement, subjects are presented with some type of treatment, such as a semester of college work experience, and then the outcome measure is applied, such as college grades. Like all experimental designs, the goal is to determine if the treatment had any effect on the outcome. Without a comparison group, it is impossible to determine if the outcome scores are any higher than they would have been without the treatment. And, without any pre-test scores, it is impossible to determine if any change within the group itself has taken place.

A.2 One Group Pretest Posttest Study

A benefit of this design over the previously discussed design is the inclusion of a pretest to determine baseline scores. To use this design in our study of college performance, we could compare college grades prior to gaining the work experience to the grades after completing a semester of work experience. We can now at least state whether a change in the outcome or dependent variable has taken place. What we cannot say is if this change would have occurred even without the application of the treatment or independent variable. It is possible that mere maturation caused the change in grades and not the work experience itself.

2. Quasi-experimental Design

Quasi designs fair better than pre-experimental studies in that they employ a means to compare groups. They fall short, however on one very important aspect of the experiment: randomization.

B.1- Pretest Posttest Nonequivalent Group.

With this design, both a control group and an experimental group is compared, however, the groups are chosen and assigned out of convenience rather than through randomization.

2. Quasi-experimental Design

B.2- Time Series Designs.

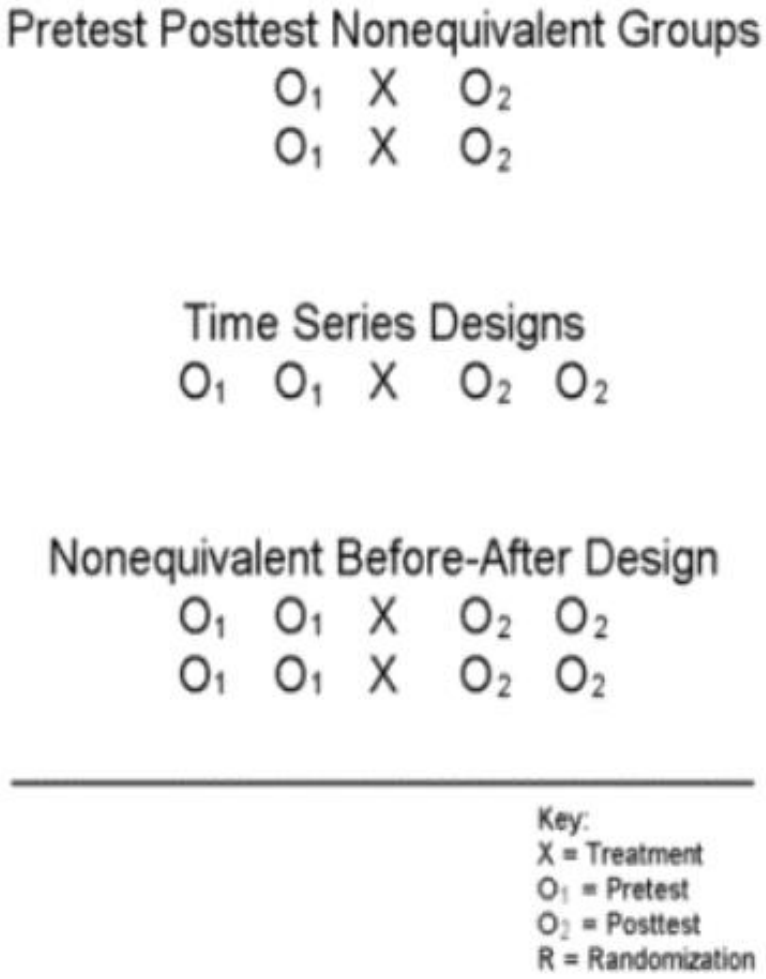
Tim series designs refer to the pretesting and posttesting of one group of subjects at different intervals. The purpose might be to determine long term effect of treatment and therefore the number of pre- and posttests can vary from one each to many. Sometimes there is an interruption between tests in order to assess the strength of treatment over an extended time period. When such a design is employed, the posttest is referred to as follow-up.

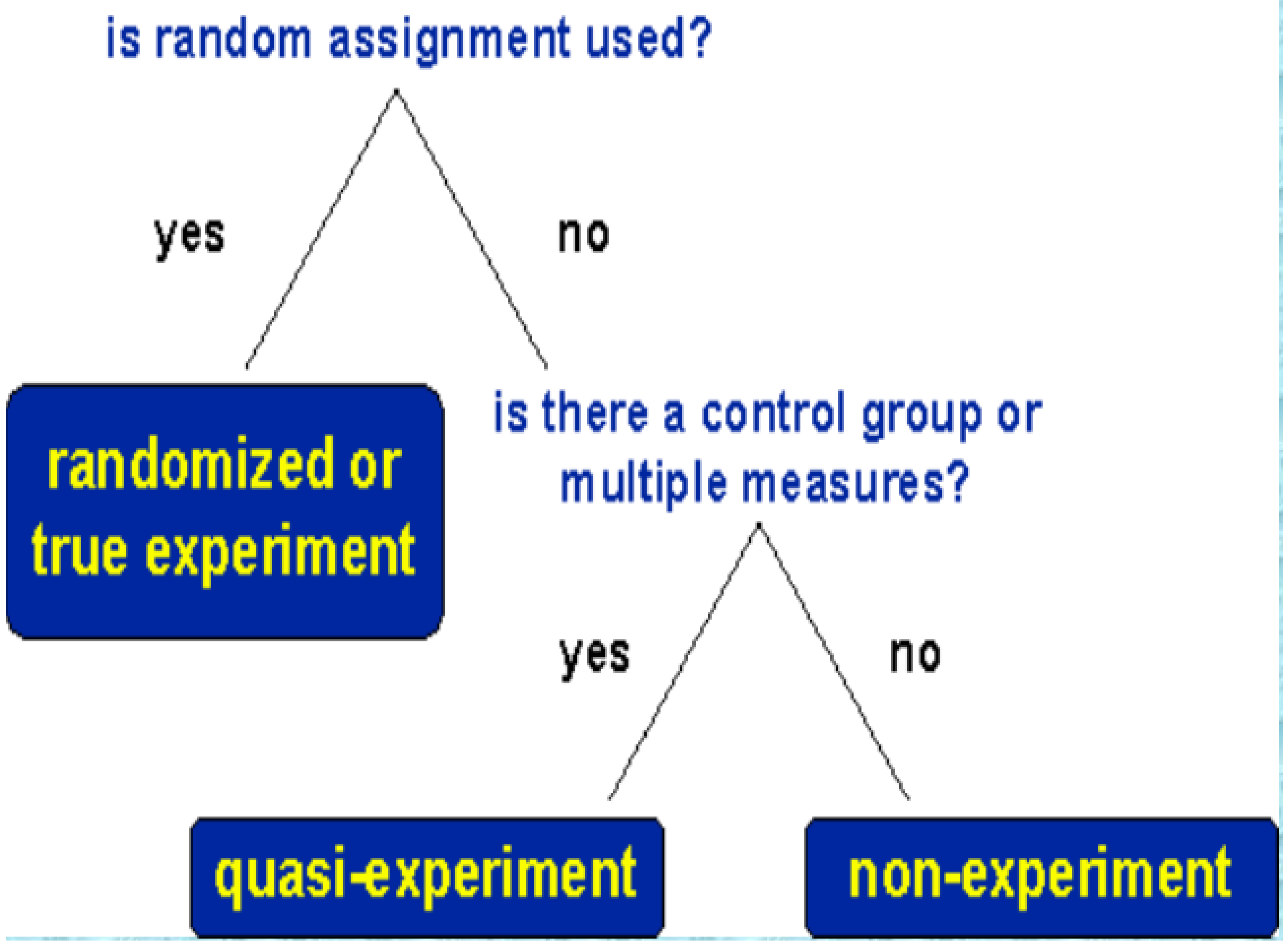
B.3- Nonequivalent Before-After Design.

This design is used when we want to compare two groups that are likely to be different even before the study begins. In other words, if we want to see how a new treatment affects people with different psychological disorders, the disorders themselves would create two or more nonequivalent groups. Once again, the number of pretests and posttests can vary from one each to many.

Whenever subjects are chosen for groups based on convenience rather than randomization, the reason for inclusion in the study itself confounds our results.

Diagrams of Quasi Experimental Designs





3. True Experimental Design

The true experiment is often thought of as the only research method that can adequately measure the cause and effect relationship.

C.1- Posttest Equivalent Groups Study.

Randomization and the comparison of both a control and an experimental group are utilized in this type of study. Each group, chosen and assigned at random is presented with either the treatment or some type of control. Posttests are then given to each subject to determine if a difference between the two groups exists. While this is approaching the best method, it falls short in its lack of a pretest measure.

C.2.-Pretest Posttest Equivalent Groups Study.

This method is the most effective in terms of demonstrating cause and effect but it is also the most difficult to perform. The pretest posttest equivalent groups design provides for both a control group and a measure of change but also adds a pretest to assess any differences between the groups prior to the study taking place.

Diagrams of True Experimental Designs

Posttest Equivalent Groups

R X O_2

R X O_2

Pretest Posttest Equivalent Groups

R O_1 X O_2

R O_1 X O_2

Key:
X = Treatment
O_1 = Pretest
O_2 = Posttest
R = Randomization

Final Word

- Research Methodology:

1. Quantitative methods
2. Qualitative methods
3. Mixed methods

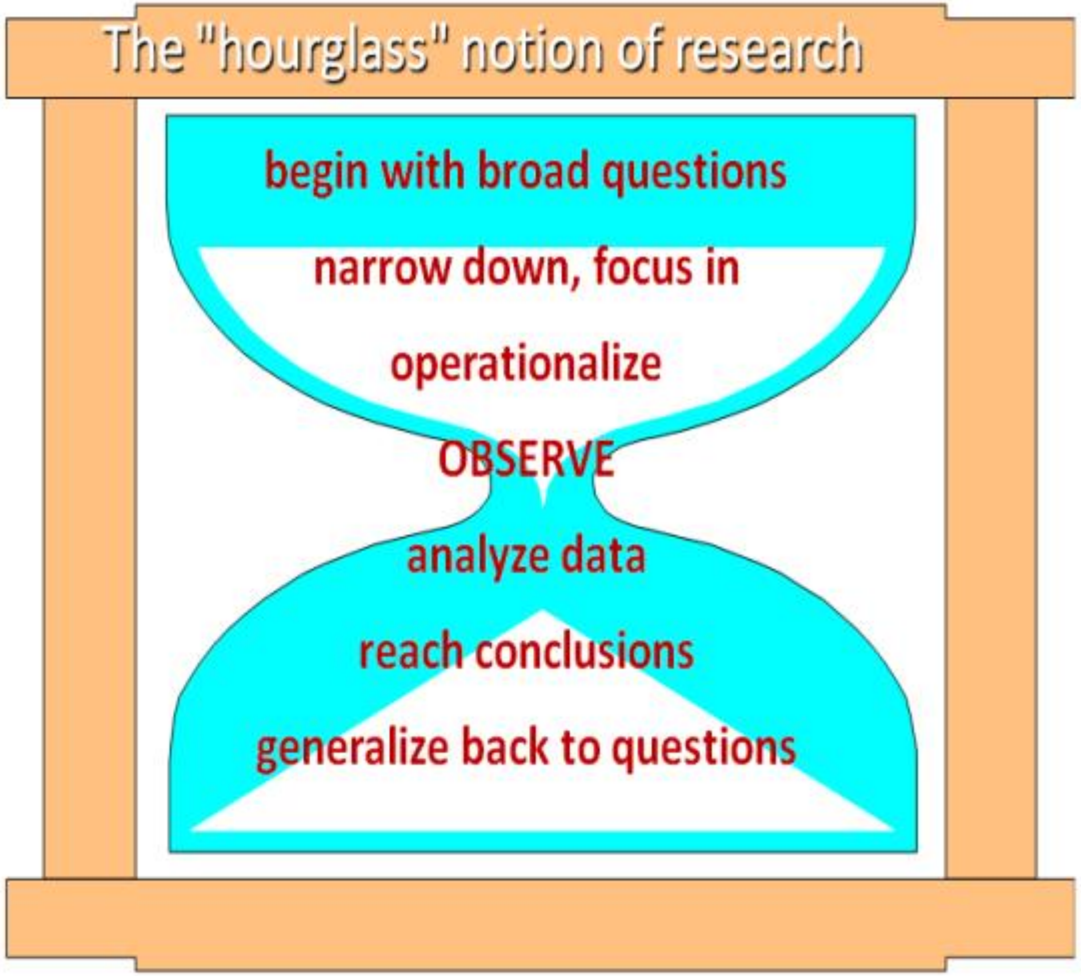
- The methodological history can be summarized as **three waves**

1. The dominance of quantitative methods as wave
2. The emergence of qualitative methods as wave
3. The growth of mixed methods as wave

The scientific approach includes the following steps:

1. Identify an area of interest/research question-RQ.
2. Generate a hypothesis from your RQ.
3. Design a study to test your hypothesis.
4. Formulate predictions based on your hypothesis.
5. Collect data/information.
6. Analyze and interpret the data to test predictions.
7. Accept or reject the hypothesis.
8. Communicate your results .
9. Refine your hypothesis based on the results.
10. Replicate the study.

Structure of Research



Criteria for a good research topic

A good research topic should be

- feasible (can be done),
- interesting,
- novel,
- ethical
- relevant (has an implication).

Feasibility

The following are examples of factors to be considered, depending on the category of research.

- It should be possible to recruit the number of subjects required to provide the answer to the research question within the timeframe of the planned research.
- The research facility available to the investigators should have the equipment, supplies and other requirements to undertake the research.
- The investigators must have the required expertise.
- The cost of doing the research must be affordable and the financial resources available.

Criteria for a good research topic

Interest

The research topic must be of interest to the investigators and to the scientific community. If the investigators are not excited about the topic, or cannot get colleagues interested in it, the project is probably not worth doing.

Criteria for a good research topic

Novelty

It is essential that the investigator is familiar with the up-to-date literature on the planned topic for the research. The research must be expected to contribute new information.

Novel does not necessarily mean that the research has not been done before. The prefix “re” in the word research implies searching again.

Most good studies are neither original nor simple duplication of other studies.

The progress of science is incremental, with knowledge gradually building up from different studies. The question should not be about whether the study has been done before, but whether it will add to the existing body of knowledge.

Criteria for a good research topic

Ethics

Ethical issues must be addressed at the early stage of selecting the research topic.

Other ethical issues will need to be addressed in planning the research. Some ethical problems may indicate that the research should not be considered from the beginning.

If the research topic involves experimentation on human subjects, the following issues should be considered.

• If the topic is about testing a new therapy or procedure, evidence should already be available to suggest that it can be superior to currently available alternatives.

• Adequate data must be available from animal studies and from studies on a small number of human subjects to confirm safety and to suggest effectiveness, before subjecting patients to a new drug or procedure It is unjustifiable to do clinical trials on therapies that are unlikely to become available to people in the country or community.

• The research should not conflict with the society's cultural, moral, religious and legal values.

Criteria for a good research topic

Relevance

This criterion can be called: the “so-what?” test. For the research to be considered relevant, it must have the potential to advance scientific knowledge, influence clinical management, influence health policy, or guide further research.