Scientific research approach

Lecture-1: The scientific research methods types

What is Research?

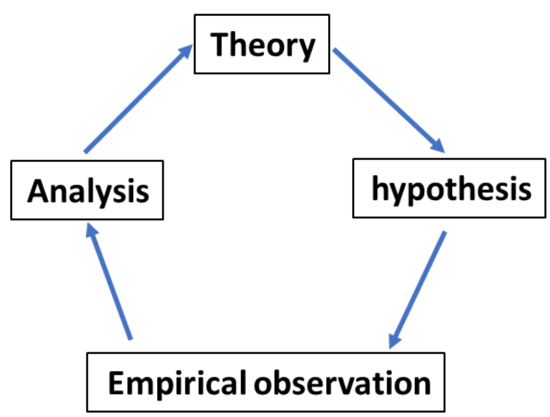
Research is defined as a careful consideration of study regarding a particular concern or a problem using scientific methods. According to the American sociologist Earl Robert Babbie, "Research is a systematic inquiry to describe, explain, predict and control the observed phenomenon. Research involves inductive and deductive methods."

Before explain the inductive and deductive methods means we should know what is the research methods cycle.

Research cycle

A circuit consisting of several steps, one leading to the others. It can begin with theory or observation. Understanding the research cycle is extremely helpful in terms of comprehending the structure of research articles.

The figure below outlines the main stages of the research cycle and they are many other stages in between different from branch of science to other. All these stages will explain down.



In any form of research, you will be required to either count things and/ or talk to people. We can broadly classify research methods using this distinction. These two types of research method and their output data are classified as:

Quantitative - as the name suggests, is concerned with trying to quantify things; it asks questions such as ‘how long’, ‘how many ‘or ‘the degree to which’. Quantitative methods look to quantify data and generalize results from a sample of the population of interest. They may look to measure the incidence of various views and opinions in a chosen sample for example or aggregate results.

Qualitative – concerned with a quality of information, qualitative methods attempt to gain an understanding of the underlying reasons and motivations for actions and establish how people interpret their experiences and the world around them. Qualitative methods provide insights into the setting of a problem, generating ideas and/or hypotheses.

The following table provides a breakdown of the key features of each of these categorization of research method and data.

	Quantitative	**Qualitative**
Aim	The aim is to count things in an attempt to explain what is observed	The aim is a complete, detailed description of what is observed
Purpose	Generalisability, prediction, causal explanations	Contextualisation, interpretation, understanding perspectives
Tools	Researcher uses tools, such as surveys, to collect numerical data.	Researcher is the data gathering Instrument
Data collection	Structured	Unstructured
Output	Data is in the form of numbers and statistics	Data is in the form of words, pictures or Objects
Sample	Usually a large number of cases representing the population of interest. Randomly selected respondents	Usually a small number of nonrepresentative cases. Respondents selected on their experience.
Objective / Subjective	Objective – seeks precise measurement & analysis	Subjective - individuals’ interpretation of events is important
Analysis	Statistical	Interpretive

What is the scientific research method or approach?

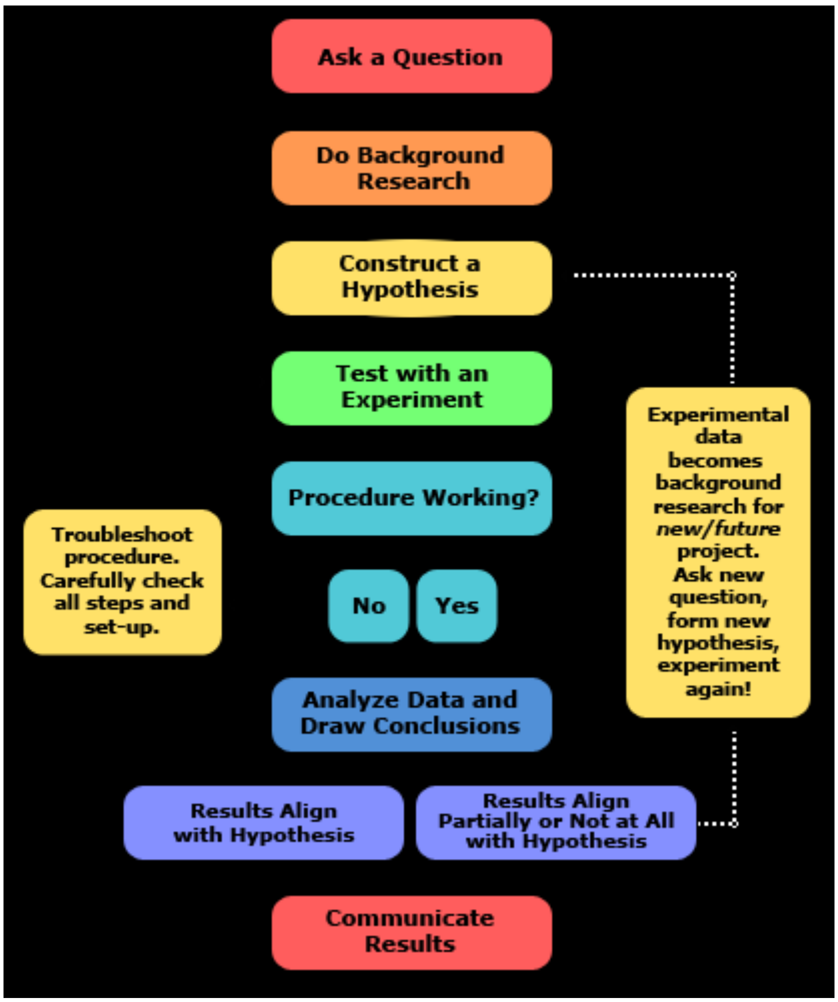
Regardless of the type of research inductive or deductive, the scientific method is the process of objectively establishing facts through testing and experimentation. The basic process involves making an observation, forming a hypothesis, making a prediction, conducting an experiment and finally analyzing the results. The principals of the scientific method can be applied in many areas, including scientific research, business and technology.

The video outlines the stages of the research method and they are explained in more detail next week.

Lecture-2: ask question and create hypothesis

Steps of the scientific method

The scientific method uses a series of steps to establish facts or create knowledge. The overall process is well established, but the specifics of each step may change depending on what is being examined and who is performing it. The scientific method can only answer questions that can be proven or disproven through testing.



The video outlines these steps and they are explained in more detail below.

1. **Make an observation or ask a question**.
   The first step is to observe something that you would like to learn about or ask a question that you would like answered. These can be specific or general.

Some examples would be "I read that hydroxychloroquine was banned from COVID-19 patients because it causes an increase in heart rate". For this observation the question could be “does the hydroxychloroquine have an impact on heart? How or why? Taking the time to establish a well-defined question will help you in later steps.

Practice section:
See the video and ask a question about any phenomena you noticed.

2. **Gather background information.**
   This involves doing research into what is already known about the topic. This can also involve finding if anyone has already asked the same question.

3. **Create a hypothesis.**
   A hypothesis is an explanation for the observation or question. If proven later, it can become a fact.
   If you have a strong conceptual understanding of the system you are studying, you should be able to write a specific, testable hypothesis that addresses your research question.
   Compared to our last example, our hypothesis would be "the hydroxychloroquine effect on CK-MB or acetylcholine levels in plasma and heart tissue of the normal mice".

   Practice section:
   See the video and create a hypothesis depend on your question.

lecture-3: make an experimental design and applied it to have results could be analyze

4. **Create a prediction and perform a test (experimental design).**

   Create a testable prediction based on the hypothesis. The test should establish a noticeable change that can be measured or observed using empirical analysis. It is also important to control for other variables during the test.

   Experiments are used to study causal relationships. You manipulate one or more independent variables and measure their effect on one or more dependent variables.

   Experimental design means creating a set of procedures to systematically test a hypothesis. A good experimental design requires a strong understanding of the system you are studying.

   There are five key steps in designing an experiment:

   1. Consider your variables and how they are related
   2. think about possible extraneous and confounding variables
   3. Design experimental treatments to manipulate your independent variable
   4. Assign subjects to groups
   5. Plan how you will measure your dependent variable

   For valid conclusions, you also need to select a representative sample and control any extraneous variables that might influence your results. If random assignment of participants to control and treatment groups is impossible, unethical, or highly difficult, consider an observational study instead.

   First step, you need to define the main variables and make predictions about how they are related. The second step, you need to think about possible extraneous and confounding variables and consider how you might control them in your experiment.

   Compared to our last example, our main variables could be the CK-MB and acetylcholine levels. If they high then the heart bets well be high. Then, the extraneous variables could be the dosage of hydroxychloroquine.

The next steps will describe how to design a controlled experiment. In a controlled experiment, you must be able to:

1. Systematically and precisely manipulate the independent variable(s).
2. Precisely measure the dependent variable(s).
3. Control any potential confounding variables.

If your study system doesn't match these criteria, there are other types of research you can use to answer your research question such as observational study or statistic study.

Third step, how you manipulate the independent variable can affect the experiment's external validity – that is, the extent to which the results can be generalized and applied to the broader world.

First, you may need to decide how widely to vary your independent variable. Second, you may need to choose how finely to vary your independent variable. Sometimes this choice is made for you by your experimental system, but often you will need to decide, and this will affect how much you can infer from your results.

For our last example: first we have to know the dosage of hydroxychloroquine that is used in the human to calculate its dosage depending on the mice's weight.

Fourth step, how you apply your experimental treatments to your test subjects is crucial for obtaining valid and reliable results.

First, you need to consider the study size: how many individuals will be included in the experiment? In general, the more subjects you include, the greater your experiment's statistical power, which determines how much confidence you can have in your results.

Then you need to randomly assign your subjects to treatment groups. Each group receives a different level of the treatment. You should also include a control group, which receives no treatment. The control group tells us what would have happened to your test subjects without any experimental intervention.

Compared to our last example, the mice that we would use should be healthy. Next, we should make experiment design. In the papers, I read that the hydroxychloroquine used either in low dosage 400mg for five days or

800mg for 10 days. So, after calculate this dosage depend on the weight of mice, the mice could divide to three groups: 1) group one will consume the high dosage of hydroxychloroquine; 2) group two will consume the low dosage; and 3) control group will not consume hydroxychloroquine.
In general, the mice number should be not less than 5 mice in every group and its better if their number more than that.
Finally, you need to decide how you'll collect data on your dependent variable outcomes. You should aim for reliable and valid measurements that minimize research bias or error. Some variables, like CK-MD, can be objectively measured with scientific instruments. Others may need to be operationalized to turn them into measurable observations for example the gender (male or female).

After that, apply the experiment design to have results.

5. **Analyze the results and draw a conclusion.**
   How precisely you measure your dependent variable also affects the kinds of statistical analysis you can use on your data.
   Experiments are always context-dependent, and a good experimental design will take into account all of the unique considerations of your study system to produce information that is both valid and relevant to your research question.
   Use the metrics, figures, or tables established before the test and see if the results match the prediction. We could use many types of statistic analyzing manually or using computer programs to test if the differences between the results are significant or not and match it with our hypothesis. Then, we discuss it and make a conclusion.

6. **Share the conclusion or decide what question to ask next or both:**
   Document the results of your experiment. By sharing the results with others, you also increase the total body of knowledge available. Your experiment may have also led to other questions, or if your hypothesis is disproven you may need to create a new one and test that.