

Creative and Scientific Thinking

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CRE252

Information Technology Department

Lecture 6



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Learning Objectives:

- Quantification and Measurement
- Quantification
- Discrete quantification
- Continuous quantification
- Measurement
- The Scientific Method
- The Many Roles of Theory

Quantification and Measurement

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Quantification and Measurement:

Turning concepts into variables:

This is done so the concept can be expressed in a form that is observable and includes some notion of degree or differentiation.

The next question is: How does one pin down that degree or differentiation?

The answer involves a two-step process:

- Quantification
- Measurement.

Quantification

- The idea of quantification **means** setting up a standard amount of a thing and putting a label on it.
- We make it possible to express abstract concepts (such as length) in a manner that provides a common reference for observation.

Quantification

- Isolating standardized units increases the power of description and analysis.
- **Example:** When Gabriel Fahrenheit established the idea of a degree of temperature, he made possible a much more useful description of hot and cold.

Quantification in social science takes two forms:

- Discrete (presence or absence)
- Continuous (variation along a continuum)

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Quantification



Discrete quantification

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Quantification: **Discrete** quantification

- **Discrete** quantification relates to counting the presence or absence of a thing.
- It also relates to counting differences of quality as they are captured in categories.

Quantification: **Discrete** quantification

- Example:
 - A **vote** for a candidate is a discrete and specific act that can be counted in a conventional manner.
 - A Student's state is a quality that can be counted as being either success, fail.

Quantification: **Continuous** quantification

- Some **quantifications** have to capture the notion of variation along a continuum.
 - **Age** is an example of a **continuous** quantification.
 - One can count the number of years in a person's age, but the quantification of age is an expression of something that is ongoing.
 - A reader of a book maybe 25.72 years old today; in a few weeks, he/she will be 26years old.

Quantification: **Continuous** quantification

- Continuous quantification deals not with discrete items but with dimensions like age, length, and time.
- The mark of continuous quantification is that the variable involved may have any value on a scale, whereas in discrete quantification, only whole numbers appear (as in counting).

Quantification: (Cont...)

- One of the distinguishing characteristics of a well developed science is the array of quantifiable variables that are useful to people working in the field.
- One of the marks of a smart scientist is the ability to find ways of quantifying important variables in a reliable and meaningful way.
- Economics has come a long way by using money as a unit of analysis

MEASUREMENT

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MEASUREMENT

Measurement is a process of **assigning numbers** to some characteristics or variables or events **according to scientific rules**.

Measurement (Cont...)

- Unfortunately for the other social sciences, there aren't such easily quantifiable units for measuring power or representing psychological stress , happiness, personal security.
- There is potential for more precise measurement.
- If quantities can be established, measurement becomes much easier.
- The most obvious measurement deals with the problem of how much:how much distance, how much money, and so forth.

Measurement (Cont...)

- Some questions of how much are **not so easy to measure**— public opinion , **for example**
 - divides opinion into favorable versus unfavorable.
 - Here, opinion is quantified as a discrete, categorical variable: “Are you for it or against it?”

Measurement (Cont...)

- Some public-opinion polls deal with this by using categories instead of two:

strongly for — somewhat for — neither for nor
against — somewhat against — against

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Reliability and Validity of Variables



Reliability and Validity of Variables:

- How do you decide which method of measurement (operational definition of a construct) is the best?
- There are **two** general criteria for **evaluating** the **quality** of any measurement procedure:
 - **Validity**
 - **Reliability**

Validity of Measurement:

Concerns the “truth” of the measurement

- it is the degree to which the measurement process measures the **variable** it claims to measure
- Example: Is the **IQ score** truly measuring intelligence?

What about size of the brain and bumps on the skull?

Reliability of Measurement:

- Measurement of a variable is said to have reliability if it produces the same result when different people use it.
- reliability is the stability or the consistency of measurement.

Reliability and error of Measurement:

- Inconsistency (lack of reliability) of measurement comes from error
- The higher the error the more unreliable the measurement

Reliability and error of Measurement:

- Sources of error
 - Observer error (the individual who makes the measurements can introduce simple **human** error into the measurement process)
 - Environmental changes (small **changes** in the **environment** from one measurement to another (time of the day, distraction الإختلاف in the room, lighting))
 - Participant changes (**participants change** between measurements (mood, hunger, motivation)).

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Hypothesis



Hypothesis:

The **purpose** of a hypothesis is to **organize** a study.

- If the hypothesis is **carefully** formed, all the **steps** of the scientific method follow.
- The hypothesis provides the **structure**.
- A **hypothesis** proposes a **relationship** between two or more **variables**.

Hypothesis:

For example: Political participation increases with education.

- It has a subject (the variable political participation), a connective verb (a relationship, increases), and an object (the variable education).

The Hypothesis

Oxford English Dictionary :

A hypothesis is a **supposition**, “which serves as a **starting point** for further **investigation** by which it may be proved or disproved....”

- A hypothesis stands at the **beginning**, not the end, of a **study**, although good studies may **suggest new paths** of fruitful inquiry and new hypotheses.

Hypothesis (Cont...)

- A hypothesis is an **observation**, usually based on a cause and effect. It is the basic idea that has **not been tested**.
- A hypothesis is just an **idea** that **explains** something . It must go through a number of experiments designed to prove or disprove it.

The Hypothesis (Cont...)

The importance of establishing a hypothesis correctly before starting off on a research can hardly be overstated. The following **rules** will help:

- First: The **variables** must be **clearly** specified and measurable by some technique you know how to use.
- Second: The **relationship** between the **variables** must be precisely stated and measurable.
- Third: The hypothesis should be **testable**, so that evidence of the relationship can be observed, demonstrated, or falsified.

The Hypothesis (Cont...)

Forth: The hypothesis, **provides the structure** for your entire research effort, whether it involves interviews and surveys, analysis of previously collected data, library research, or all three.

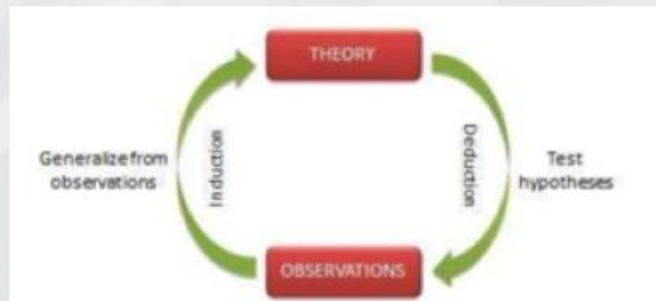
- It will **direct** you to **relevant information** so you do not waste time and effort.
- The **variables** you have selected can be **researched** through library search engines, Internet resources such as Google Scholar, book indexes, periodical guides, online services , and other computer database searches.

The Hypothesis (Cont...)

- The **relationships** proposed between the variables suggest the **measurement** tools and standards for evaluation that you will need to use.
- The **results** of the hypothesis test are the substance of your **conclusions**.

The Hypothesis (Cont...)

- Once relationships between variables have been established through hypothesis formation and testing, these relationships can be expressed as generalizations.
- Generalizations based on tested relationships are the object of science.
- A generalization is a hypothesis affirmed by testing.
- As generalizations in a field of study accumulate, they form the raw stuff of theories.



A hypothesis should always:



- *explain what you expect to happen*
- *be clear and understandable*
- *be testible*
- *be measurable*
- *contain an independent and dependent variable*

Examples of Hypotheses

Question	Hypothesis	Example
How does the size of a dog affect how much food it eats?	Larger animals of the same species expend more energy than smaller animals of the same type. To get the energy their bodies need, the larger animals eat more food.	If I let a 70-pound dog and a 30-pound dog eat as much food as they want, then the 70-pound dog will eat more than the 30-pound dog.
Does fertilizer make a plant grow bigger?	Plants need many types of nutrients to grow. Fertilizer adds those nutrients to the soil, thus allowing plants to grow more.	If I add fertilizer to the soil of some tomato seedlings, but not others, then the seedlings that got fertilizer will grow taller and have more leaves than the non-fertilized ones.

Examples of Hypotheses

Question	Hypothesis	Example
Does an electric motor turn faster if you increase the current ?	Electric motors work because they have electromagnets inside them, which push/pull on permanent magnets and make the motor spin. As more current flows through the motor's electromagnet, the strength of the magnetic field increases, thus turning the motor faster.	If I increase the current supplied to an electric motor, then the RPMs(revolutions per minute) of the motor will increase.
Is a classroom noisier when the teacher leaves the room ?	Teachers have rules about when to talk in the classroom . If they leave the classroom, the students feel free to break the rules and talk more , making the room nosier.	If I measure the noise level in a classroom when a teacher is in it and when she leaves the room, then I will see that the noise level is higher when my teacher is not in my classroom.

Thank You