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Research Methodology

Key Concepts of the Scientific Method

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There are several important aspects to research methodology. This is a summary of the key concepts in scientific research and an attempt to erase some common misconceptions in science.

Steps of the scientific method [1] are shaped like an hourglass - starting from general questions, narrowing down to focus on one specific aspect [2], and designing research [3] where we can observe [4] and analyze this aspect. At last, we conclude [5] and generalize [6] to the real world.

Formulating a Research Problem

Researchers organize their research by formulating and defining a research problem [2]. This helps them focus the research process [7] so that they can draw conclusions [5] reflecting the real world in the best possible way.

Hypothesis

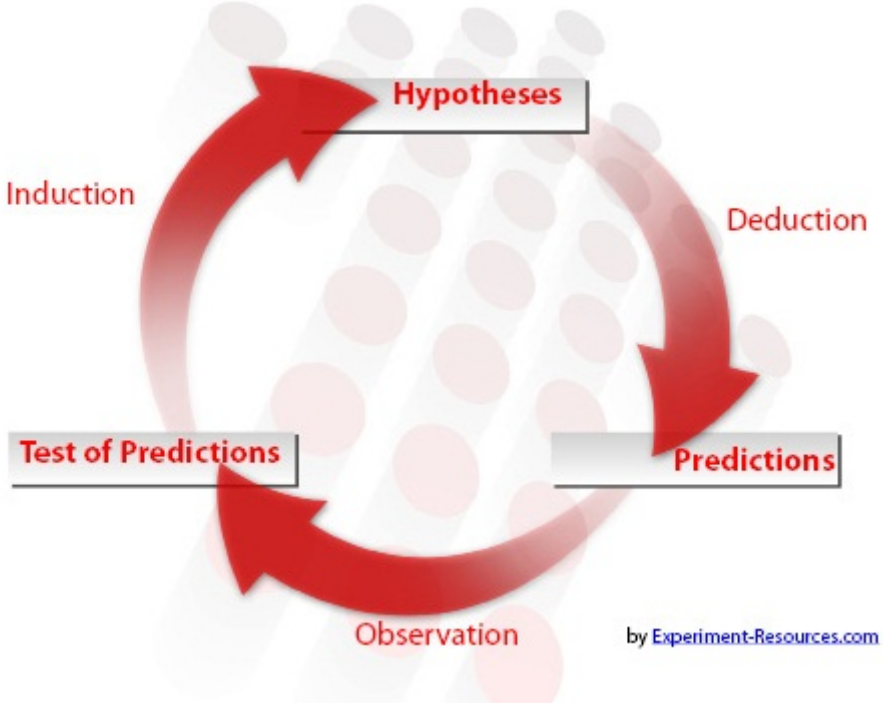
In research, a hypothesis is a suggested explanation of a phenomenon.

A null hypothesis [8] is a hypothesis which a researcher tries to disprove. Normally, the null hypothesis represents the current view/explanation of an aspect of the world that the researcher wants to challenge.

Research methodology involves the researcher providing an alternative hypothesis, a research hypothesis [9], as an alternate way to explain the phenomenon.

The researcher tests the hypothesis [10] to disprove the null hypothesis, not because he/she loves the research hypothesis, but because it would mean coming closer to finding an answer to a specific problem. The research hypothesis is often based on observations [4] that evoke suspicion that the null hypothesis is not always correct.

In the Stanley Milgram Experiment [11], the null hypothesis was that the personality determined whether a person would hurt another person, while the research hypothesis was that the role, instructions and orders were much more important in determining whether people would hurt others.



Variables

A variable [12] is something that changes. It changes according to different factors. Some variables change easily, like the stock-exchange value, while other variables are almost constant, like the name of someone. Researchers are often seeking to measure [13] variables.

The variable can be a number, a name, or anything where the value can change.

An example of a variable is temperature. The temperature varies according to other variable and factors. You can measure different temperature inside and outside. If it is a sunny day, chances are that the temperature will be higher than if it's cloudy. Another thing that can make the temperature change is whether something has been done to manipulate the temperature, like lighting a fire in the chimney.

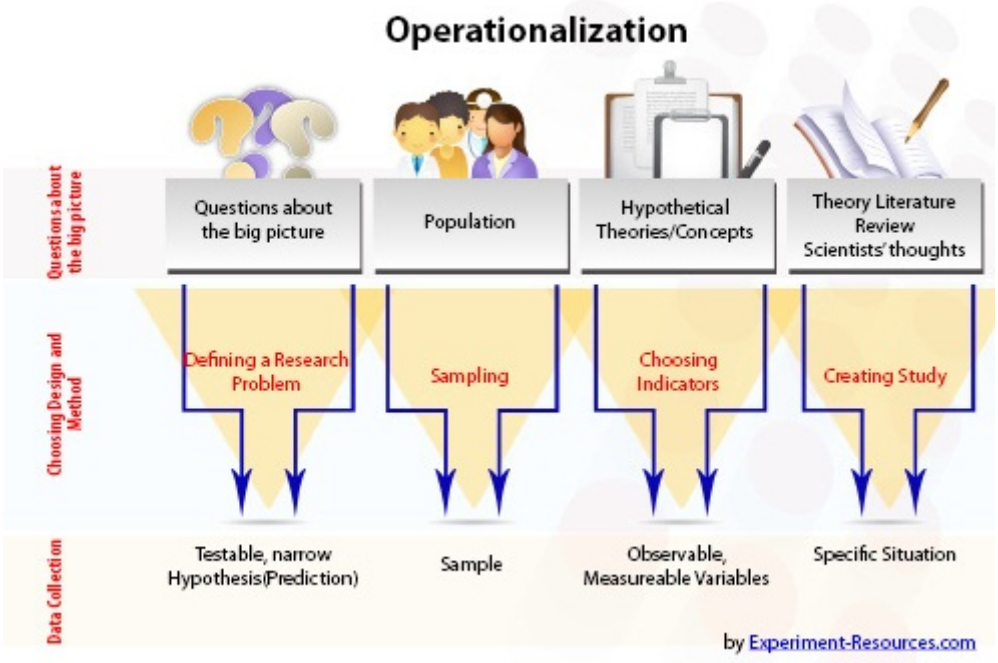
In research, you typically define variables according to what you're measuring. The independent variable [14] is the variable which the researcher would like to measure (the cause), while the dependent variable [15] is the effect (or assumed effect), dependent on the independent variable. These variables are often stated in experimental research [16], in a hypothesis [9], e.g. "what is the effect of personality on helping behavior?"

In explorative research methodology, e.g. in some qualitative research [17], the independent and the dependent variables might not be identified beforehand. They might not be stated because the researcher does not have a clear idea yet on what is really going on.

Confounding variables [18] are variables with a significant effect on the dependent variable that the researcher failed to control [19] or eliminate - sometimes because the researcher is not aware of the effect of the confounding variable. The key is to identify possible confounding variables and somehow try to eliminate or control them.

Operationalization

Operationalization [20] is to take a fuzzy concept (conceptual variables [21]), such as 'helping behavior [22]', and try to measure it by specific observations, e.g. how likely are people to help a stranger with problems.



See also:

Conceptual Variables [21]

Choosing the Research Method

The selection of the research method [23] is crucial for what conclusions [5] you can make about a phenomenon. It affects what you can say about the cause and factors influencing the phenomenon.

It is also important to choose a research method which is within the limits of what the researcher can do. Time, money, feasibility, ethics [24] and availability to measure the phenomenon correctly are examples of issues constraining the research.

Choosing the Measurement

Choosing the scientific measurements [13] are also crucial for getting the correct conclusion. Some measurements might not reflect the real world, because they do not measure the phenomenon as it should.

Results

Significance Test

To test a hypothesis [10], quantitative research [25] uses significance tests [26] to determine which hypothesis is right.

The significance test can show whether the null hypothesis is more likely correct than the research hypothesis. Research methodology in a number of areas like social sciences depends heavily on significance tests.

A significance test may even drive the research process in a whole new direction, based on the findings.

The t-test [27] (also called the Student's T-Test) is one of many statistical [28] significance tests, which compares two supposedly equal sets of data to see if they really are alike or not. The t-test helps the researcher conclude whether a hypothesis is supported or not.

Drawing Conclusions

Drawing a conclusion [5] is based on several factors of the research process, not just because the researcher got the expected result. It has to be based on the validity and reliability [29] of the measurement, how good the measurement was to reflect the real world and what more could have affected the results.

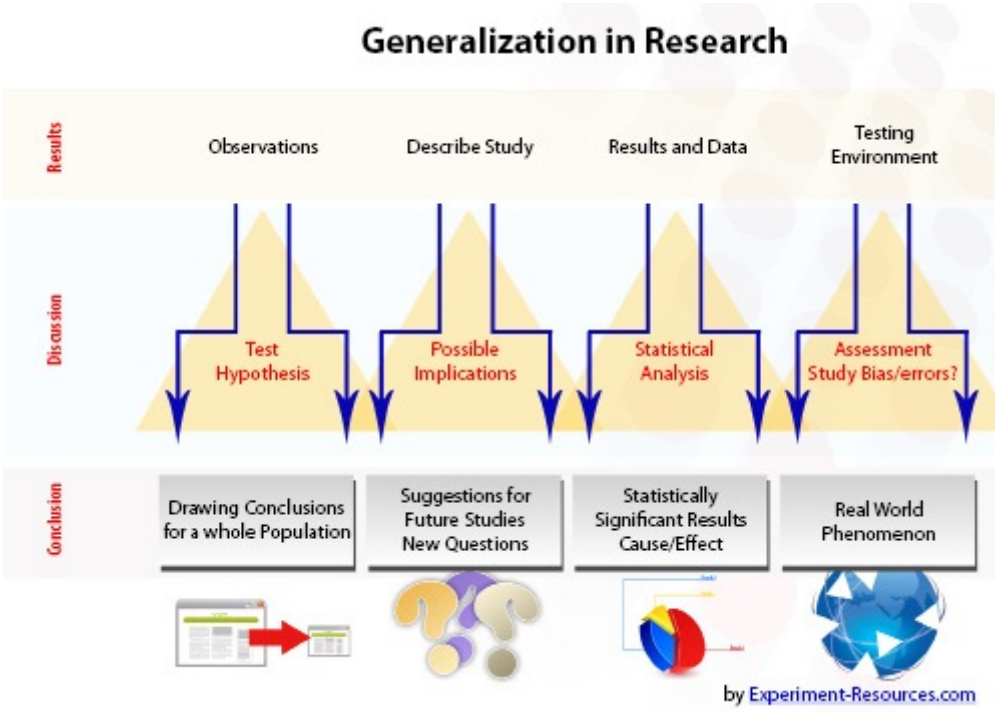
The observations are often referred to as 'empirical evidence [30]' and the logic/thinking leads to the conclusions. Anyone should be able to check the observation and logic, to see if they also reach the same conclusions.

Errors of the observations may stem from measurement-problems, misinterpretations, unlikely random events etc.

A common error is to think that correlation implies a causal relationship [31]. This is not necessarily true.

Generalization

Generalization [6] is to which extent the research and the conclusions [5] of the research apply to the real world. It is not always so that good research will reflect the real world, since we can only measure [13] a small portion of the population [32] at a time.



Validity and Reliability

Validity refers to what degree the research reflects the given research problem, while Reliability refers to how consistent a set of measurements are.

Types of validity [33]:

- External Validity [34]
- Population Validity [35]
- Ecological Validity [36]
- Internal Validity [37]
- Content Validity [38]
- Face Validity [39]
- Construct Validity [40]
- Convergent and Discriminant Validity [41]

- Test Validity [42]
- Criterion Validity [43]
- Concurrent Validity [44]
- Predictive Validity [45]

A definition of reliability [46] may be "Yielding the same or compatible results in different clinical experiments or statistical trials" (the free dictionary [47]). Research methodology lacking reliability cannot be trusted. Replication studies [48] are a way to test reliability.

Types of Reliability:

- Test-Retest Reliability [49]
- Interrater Reliability [50]
- Internal Consistency Reliability [51]
- Instrument Reliability [52]
- Statistical Reliability [53]
- Reproducibility [54]

Both validity and reliability [29] are important aspects of the research methodology to get better explanations of the world.

Errors in Research

Logically, there are two types of errors [55] when drawing conclusions in research:

Type 1 error [56] is when we accept the research hypothesis [9] when the null hypothesis is in fact correct.

Type 2 error [56] is when we reject the research hypothesis even if the null hypothesis [8] is wrong.

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