Experimental Research

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Experimental research is commonly used in sciences such as sociology and psychology, physics, chemistry, biology and medicine etc.

It is a collection of research designs which use manipulation and controlled testing to understand causal processes. Generally, one or more variables are manipulated to determine their effect on a dependent variable.

> The experimental method
>
> is a systematic and scientific approach to research in which the researcher manipulates one or more variables, and controls and measures any change in other variables.

Experimental Research is often used where:

1. There is time priority in a causal relationship (cause precedes effect)
2. There is consistency in a causal relationship (a cause will always lead to the same effect)
3. The magnitude of the correlation is great.

(Reference: en.wikipedia.org)

The word experimental research has a range of definitions. In the strict sense, experimental research is what we call a true experiment.

This is an experiment where the researcher manipulates one variable, and control/randomizes the rest of the variables. It has a control group, the subjects have been randomly assigned between the groups, and the researcher only tests one effect at a time. It is also important to know what variable(s) you want to test and measure.

A very wide definition of experimental research, or a quasi experiment, is research where the scientist actively influences something to observe the consequences. Most experiments tend to fall in between the strict and the wide definition.

A rule of thumb is that physical sciences, such as physics, chemistry and geology tend to define experiments more narrowly than social sciences, such as sociology and psychology, which conduct experiments closer to the wider definition.

Aims of Experimental Research

Experiments are conducted to be able to predict phenomenons. Typically, an experiment is constructed to be able to explain some kind of causation [1]. Experimental research is important to society [2] - it helps us to improve our everyday lives.

Identifying the Research Problem

After deciding the topic of interest, the researcher tries to define the research problem [3]. This helps the researcher to focus on a more narrow research area to be able to study it appropriately. Defining the research problem helps you to formulate a research hypothesis [4] , which is tested against the null hypothesis [5].

The research problem is often operationalizationed [6], to define how to measure the research problem. The results will depend on the exact measurements [7] that the researcher chooses and may be operationalized differently in another study to test the main conclusions of the study.

An ad hoc analysis [8] is a hypothesis invented after testing is done, to try to explain why the contrary evidence. A poor ad hoc analysis may be seen as the researcher's inability to accept that his/her hypothesis is wrong, while a great ad hoc analysis may lead to more testing and possibly a significant discovery.

Constructing the Experiment

There are various aspects to remember when constructing an experiment. Planning ahead ensures that the experiment is carried out properly and that the results reflect the real world, in the best possible way.

Sampling Groups to Study

Sampling [9] groups correctly is especially important when we have more than one condition in

the experiment. One sample group [10] often serves as a control group [11], whilst others are tested under the experimental conditions.

Deciding the sample groups can be done in using many different sampling techniques. Population sampling [12] may chosen by a number of methods, such as randomization [13], "quasi-randomization" and pairing.

Reducing sampling errors [14] is vital for getting valid results from experiments. Researchers often adjust the sample size [15] to minimize chances of random errors [16].

Here are some common sampling techniques [17]:

- probability sampling [18]
- non-probability sampling [19]
- simple random sampling [20]
- convenience sampling [21]
- stratified sampling [22]
- systematic sampling [23]
- cluster sampling [24]
- sequential sampling [25]
- disproportional sampling [26]
- judgmental sampling [27]
- snowball sampling [28]
- quota sampling [29]

Creating the Design

The research design is chosen based on a range of factors. Important factors when choosing the design are feasibility, time, cost, ethics, measurement problems and what you would like to test. The design of the experiment [30] is critical for the validity [31] of the results.

Typical Designs and Features in Experimental Design

- Pretest-Posttest Design [32]
  Check whether the groups are different before the manipulation starts and the effect of the manipulation. Pretests sometimes influence the effect.
- Control Group [11]
  Control groups are designed to measure research bias [33] and measurement effects, such as the Hawthorne Effect [34] or the Placebo Effect [35]. A control group is a group not receiving the same manipulation as the experimental group. Experiments frequently have 2 conditions, but rarely more than 3 conditions at the same time.
- Randomized Controlled Trials [36]
  Randomized Sampling, comparison between an Experimental Group and a Control Group and strict control/randomization of all other variables
- Solomon Four-Group Design [37]
  With two control groups and two experimental groups. Half the groups have a pretest and half do not have a pretest. This to test both the effect itself and the effect of the pretest.
- Between Subjects Design [38]
  Grouping Participants to Different Conditions

- Within Subject Design [39]
  Participants Take Part in the Different Conditions - See also: Repeated Measures Design [40]
- Counterbalanced Measures Design [41]
  Testing the effect of the order of treatments when no control group is available/ethical
- Matched Subjects Design [42]
  Matching Participants to Create Similar Experimental- and Control-Groups
- Double-Blind Experiment [43]
  Neither the researcher, nor the participants, know which is the control group. The results can be affected if the researcher or participants know this.
- Bayesian Probability [44]
  Using bayesian probability to "interact" with participants is a more "advanced" experimental design. It can be used for settings were there are many variables which are hard to isolate. The researcher starts with a set of initial beliefs, and tries to adjust them to how participants have responded

Pilot Study

It may be wise to first conduct a pilot-study [45] or two before you do the real experiment. This ensures that the experiment measures what it should, and that everything is set up right.

Minor errors, which could potentially destroy the experiment, are often found during this process. With a pilot study, you can get information about errors and problems, and improve the design, before putting a lot of effort into the real experiment.

If the experiments involve humans, a common strategy is to first have a pilot study with someone involved in the research, but not too closely, and then arrange a pilot with a person who resembles the subject(s) [46]. Those two different pilots are likely to give the researcher good information about any problems in the experiment.

Conducting the Experiment

An experiment is typically carried out by manipulating a variable, called the independent variable [47], affecting the experimental group. The effect that the researcher is interested in, the dependent variable(s) [48], is measured.

Identifying and controlling non-experimental factors which the researcher does not want to influence the effects, is crucial to drawing a valid conclusion. This is often done by controlling variables [49], if possible, or randomizing variables to minimize effects that can be traced back to third variables [50]. Researchers only want to measure the effect of the independent variable(s) when conducting an experiment [51], allowing them to conclude that this was the reason for the effect.

Analysis and Conclusions

In quantitative research [52], the amount of data measured can be enormous. Data not prepared to be analyzed is called "raw data". The raw data is often summarized as something called "output data", which typically consists of one line per subject [46] (or item). A cell of the output data is, for example, an average of an effect in many trials for a subject. The output

data is used for statistical analysis, e.g. significance tests, to see if there really is an effect.

The aim of an analysis is to draw a conclusion [53], together with other observations. The researcher might generalize [54] the results to a wider phenomenon, if there is no indication of confounding variables [50] "polluting" the results.

If the researcher suspects that the effect stems from a different variable than the independent variable, further investigation is needed to gauge the validity [55] of the results. An experiment is often conducted because the scientist wants to know if the independent variable is having any effect upon the dependent variable. Variables correlating are not proof that there is causation [56].

Experiments are more often of quantitative [52] nature than qualitative [57] nature, although it happens.

Examples of Experiments

This website contains many examples of experiments. Some are not true experiments [58], but involve some kind of manipulation to investigate a phenomenon. Others fulfill most or all criteria of true experiments.

Here are some examples of scientific experiments:

Social Psychology

- Stanley Milgram Experiment [59] - Will people obey orders, even if clearly dangerous?
- Asch Experiment [60] - Will people conform to group behavior?
- Stanford Prison Experiment [61] - How do people react to roles? Will you behave differently?
- Good Samaritan Experiment [62] - Would You Help a Stranger? - Explaining Helping Behavior

Genetics

- Law Of Segregation [63] - The Mendel Pea Plant Experiment
- Transforming Principle [64] - Griffith's Experiment about Genetics

Physics

- Ben Franklin Kite Experiment [65] - Struck by Lightning
- J J Thomson Cathode Ray Experiment [66]

Links
[1] https://explorable.com/cause-and-effect
[2] https://explorable.com/experimental-research-and-society
[3] https://explorable.com/defining-a-research-problem
[4] https://explorable.com/research-hypothesis
[5] https://explorable.com/null-hypothesis
[6] https://explorable.com/operationalization
[7] https://explorable.com/scientific-measurements

[8] https://explorable.com/ad-hoc-analysis
[9] https://explorable.com/what-is-sampling
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[65] https://explorable.com/ben-franklin-kite-experiment
[66] https://explorable.com/cathode-ray-experiment