Conducting an Experiment

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Science revolves around experiments, and learning the best way of conducting an experiment is crucial to obtaining useful and valid results.

When scientists speak of experiments, in the strictest sense of the word, they mean a true experiment, where the scientist controls all of the factors and conditions.

Real world observations, and case studies, should be referred to as observational research, rather than experiments.

For example, observing animals in the wild is not a true experiment, because it does not isolate and manipulate an independent variable.

The Basis of Conducting an Experiment

With an experiment, the researcher is trying to learn something new about the world, an explanation of 'why' something happens.

The experiment must maintain internal [1] and external [2] validity, or the results [3] will be useless.

When designing an experiment [4], a researcher must follow all of the steps of the scientific method [5], from making sure that the hypothesis [6] is valid and testable [7], to using controls and statistical [8] tests.

Whilst all scientists use reasoning [9], operationalization [10] and the steps of the scientific process [5], it is not always a conscious process.

Experience and practice mean that many scientists follow an instinctive process of conducting an experiment, the 'streamlined' scientific process [11]. Following the basic steps will usually generate valid results, but where experiments are complex and expensive, it is always advisable to follow the rigorous scientific protocols. Conducting an experiment [12] has a number of stages, where the parameters and structure of the experiment are made clear.

Whilst it is rarely practical to follow each step strictly, any aberrations must be justified, whether they arise because of budget, impracticality or ethics [13].

Stage One

After deciding upon a hypothesis [6], and making predictions, the first stage of conducting an experiment is to specify the sample groups. These should be large enough to give a statistically viable study, but small enough to be practical.

Ideally, groups should be selected at random [14], from a wide selection of the sample population. This allows results to be generalized [15] to the population as a whole.

In the physical sciences, this is fairly easy, but the biological and behavioral sciences are often limited by other factors.

For example, medical trials often cannot find random groups. Such research often relies upon volunteers, so it is difficult to apply any realistic randomization [16]. This is not a problem, as long as the process is justified, and the results are not applied to the population as a whole.

If a psychological researcher used volunteers who were male students, aged between 18 and 24, the findings can only be generalized to that specific demographic group within society.

Stage Two

The sample groups [17] should be divided, into a control group [18] and a test group, to reduce the possibility of confounding variables [19].

This, again, should be random, and the assigning of subjects to groups should be blind or double blind [20]. This will reduce the chances of experimental error [21], or bias, when conducting an experiment.

Ethics [13] are often a barrier to this process, because deliberately withholding treatment, as with the Tuskegee study [22], is not permitted.

Again, any deviations from this process must be explained in the conclusion. There is nothing wrong with compromising upon randomness, where necessary, as long as other scientists are aware of how, and why, the researcher selected groups on that basis.

Stage Three

This stage of conducting an experiment involves determining the time scale and frequency of sampling [17], to fit the type of experiment.

For example, researchers studying the effectiveness of a cure for colds would take frequent samples, over a period of days. Researchers testing a cure for Parkinson's disease would use less frequent tests, over a period of months or years.

Stage Four

The penultimate stage of the experiment involves performing the experiment according to the methods stipulated during the design phase.

The independent variable [23] is manipulated, generating a usable data set for the dependent variable [24].

Stage Five

The raw data [25] from the results should be gathered, and analyzed, by statistical [8] means. This allows the researcher to establish if there is any relationship between the variables and accept, or reject, the null hypothesis [26].

These steps are essential to providing excellent results. Whilst many researchers do not want to become involved in the exact processes of inductive reasoning [27], deductive reasoning [28] and operationalization [10], they all follow the basic steps of conducting an experiment. This ensures that their results are valid [29].

Reasoning Cycle - Scientific Research

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Preparing a Coordination Schema of the Whole Research Plan

Preparing a coordination schema of the research plan may be another useful tool in undertaking research planning. While preparing a coordination schema, one may have to identify the broad variable in the form of parameters, complex variables and disaggregate those in the form of simple variables. Coordination Schema: A Methodological Tool in Research Planning by Purnima Mohapatra is a very useful tool. Arranging everything in a schema not only makes the research more organised, it also saves a lot of valuable time for the researcher.

Links
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[3] https://verify.explorable.com/statistically-significant-results
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