

Empirical Research: Definition and steps of the empirical cycle

Empirical Research

Is a way of gaining knowledge by means of direct and indirect observation or experience. Empirical evidence (the record of one's direct observations or experiences) can be analyzed quantitatively or qualitatively. Through quantifying the evidence or making sense of it in qualitative form, a researcher can answer empirical questions, which should be clearly defined and answerable with the evidence collected (usually called data). Research design varies by field and by the question being investigated. Many researchers combine qualitative and quantitative forms of analysis to better answer questions which cannot be studied in laboratory settings, particularly in the social sciences and in education.

In some fields, quantitative research may begin with a research question (e.g., "Does listening to vocal music during the learning of a word list have an effect on later memory for these words?") which is tested through experimentation in a lab. Usually, a researcher has a certain theory regarding the topic under investigation. Based on this theory some statements, or hypotheses, will be proposed (e.g., "Listening to vocal music has a negative effect on learning a word list."). From these hypotheses predictions about specific events are derived (e.g., "People who study a word list while listening to vocal music will remember fewer words on a later memory test than people who study a word list in silence."). These predictions can then be tested with a suitable experiment. Depending on the outcomes of the experiment, the theory on which the hypotheses and predictions were based will be supported or not.

Terminology

The term empirical was originally used to refer to certain ancient Greek practitioners of medicine who rejected adherence to the dogmatic doctrines of the day, preferring instead to rely on the observation of phenomena as perceived in experience. Later empiricism referred to a theory of knowledge in philosophy which adheres to the principle that knowledge arises from experience and evidence gathered specifically using the senses. In scientific use the term empirical refers to the gathering of data using only evidence that is observable by the senses or in some cases using calibrated scientific instruments. What early philosophers described as empiricist and empirical research have in common is the dependence on observable data to formulate and test theories and come to conclusions.

Usage

The researchers attempts to describe accurately the interaction between the instrument (or the human senses) and the entity being observed. If instrumentation is involved, the researcher is expected to calibrate his/her instrument by applying it to known standard objects and documenting the results before applying it to unknown objects. In other words, it describes the research that has not been taken place before and their results.

In practice, the accumulation of evidence for or against any particular theory involves planned research designs for the collection of empirical data, and academic rigor plays a large part of judging the merits of research design. Several typographies for such designs have been suggested, one of the most popular of which comes from Campbell and Stanley (1963). They are responsible for popularizing the widely cited distinction among pre-experimental, experimental, and quasi-experimental designs and are staunch advocates of the central role of randomized experiments in educational research.

Scientific research

Accurate analysis of data using standardized statistical methods in scientific studies is critical to determining the validity of empirical research. Statistical formulas such as regression, uncertainty coefficient, t-test, chi square, and various types of ANOVA (analyses of variance) are fundamental to forming logical, valid conclusions. If empirical data reach significance under the appropriate statistical formula, the research hypothesis is supported. If not, the null hypothesis is supported (or, more correctly, not rejected), meaning no effect of the independent variable(s) was observed on the dependent variable(s).

It is important to understand that the outcome of empirical research using statistical hypothesis testing is never proof. It can only *support* a hypothesis, *reject* it, or do neither. These methods yield only probabilities.

Among scientific researchers, empirical *evidence* (as distinct from empirical *research*) refers to objective evidence that appears the same regardless of the observer. For example, a thermometer will not display different temperatures for each individual who observes it. Temperature, as measured by an accurate, well calibrated thermometer, is empirical evidence. By contrast, non-empirical evidence is subjective, depending on the observer. Following the previous example, observer A might truthfully report that a room is warm, while observer B might truthfully report that the same room is cool, though both observe the same reading on the thermometer. The use of empirical evidence negates this effect of personal (i.e., subjective) experience.

Empirical cycle

Empirical cycle according to A.D. de Groot

1. Observation: The collecting and organization of empirical facts; Forming hypothesis.
2. Induction: Formulating hypothesis.
3. Deduction: Deducing consequences of hypothesis as testable predictions.
4. Testing: Testing the hypothesis with new empirical material.
5. Evaluation: Evaluating the outcome of testing or else



STEPS IN EMPIRICAL RESEARCH

The ideal research proposal should be comprehensive enough to enable the reader to know everything that could be expected to happen if the project were actually carried out--including anticipated obstacles as well as anticipated benefits. In order to design a research project, you may wish to ask yourself the following series of questions:

1. PROBLEM STATEMENT, PURPOSES, BENEFITS, what exactly do I want to find out? What is a researchable problem? What are the obstacles in terms of knowledge, data availability, time, or resources? Do the benefits outweigh the costs?

2. THEORY, ASSUMPTIONS, BACKGROUND LITERATURE, what does the relevant literature in the field indicate about this problem? To which theory or conceptual framework can I link it? What are the criticisms of this approach, or how does it constrain the research process? What do I know for certain about this area? What is the history of this problem that others need to know?

3. VARIABLES AND HYPOTHESES, what will I take as given in the environment? Which are the independent and which are the dependent variables? Are there control variables? Is the hypothesis specific enough to be researchable yet still meaningful? How certain am I of the relationship(s) between variables?

4. OPERATIONAL DEFINITIONS AND MEASUREMENT, what is the level of aggregation? What is the unit of measurement? How will the research variables be measured? What degree of error in the findings is tolerable? Will other people agree with my choice of measurement operations?

5. RESEARCH DESIGN AND METHODOLOGY, what is my overall strategy for doing this research? Will this design permit me to answer the research question? What other possible

causes of the relationship between the variables will be controlled for by this design? What are the threats to internal and external validity?

6. SAMPLING, how will I choose my sample of persons or events? Am I interested in representativeness? If so, of whom or what, and with what degree of accuracy or level of confidence?

7. INSTRUMENTATION, how will I get the data I need to test my hypothesis? What tools or devices will I use to make or record observations? Are valid and reliable instruments available, or must I construct my own?

8. DATA COLLECTION AND ETHICAL CONSIDERATIONS, are there multiple groups, time periods, instruments, or situations that will need to be coordinated as steps in the data collection process? Will interviewers, observers, or analysts need to be trained? What level of inter-rater reliability will I accept? Do multiple translations pose a potential problem? Can the data be collected and subjects' rights still preserved?

9. DATA ANALYSIS, what combinations of analytical and statistical process will be applied to the data? Which will allow me to accept or reject my hypotheses? Do the findings show numerical differences, and are those differences important?

10. CONCLUSIONS, INTERPRETATIONS, RECOMMENDATIONS, was my initial hypothesis supported? What if my findings are negative? What are the implications of my findings for the theory base, for the background assumptions, or relevant literature? What recommendations can I make for public policies or programs in this area? What suggestions can I make for further research on this topic?