Empirical Research [1]

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Empirical research is the process of testing a hypothesis using experimentation, direct or indirect observation and experience.

The word empirical describes any information gained by experience, observation, or experiment [3]. One of the central tenets of the scientific method [4] is that evidence must be empirical, i.e. based on evidence observable to the senses.

Philosophically, empiricism defines a way of gathering knowledge by direct observation and experience rather than through logic or reason alone (in other words, by rationality). In the scientific paradigm the term refers to the use of hypotheses [5] that can be tested using observation [6] and experiment. In other words, it is the practical application of experience via formalized experiments.

Empirical data is produced by experiment and observation, and can be either quantitative or qualitative.

Objectives of Empirical Research

Empirical research is informed by observation, but goes far beyond it. Observations alone are merely observations. What constitutes empirical research is the scientist's ability to formally operationalize those observations using testable research questions.

In well-conducted research, observations about the natural world are cemented in a specific research question or hypothesis. The observer can make sense of this information by recording results quantitatively or qualitatively.

Techniques will vary according to the field, the context and the aim of the study. For example, qualitative methods are more appropriate for many social science questions and quantitative methods more appropriate for medicine or physics.

However, underlying all empirical research is the attempt to make observations and then answer well-defined questions via the acceptance or rejection of a hypothesis, according to those observations.

Empirical research can be thought of as a more structured way of asking a question – and testing it. Conjecture, opinion, rational argument or anything belonging to the metaphysical or

abstract realm are also valid ways of finding knowledge. Empiricism, however, is grounded in the “real world” of the observations given by our senses.

Reasons for Using Empirical Research Methods

Science in general and empiricism specifically attempts to establish a body of knowledge about the natural world. The standards of empiricism exist to reduce any threats to the validity of results obtained by empirical experiments. For example, scientists take great care to remove bias, expectation and opinion from the matter in question and focus *only* on what can be empirically supported.

By continually grounding all enquiry in what can be repeatedly backed up with evidence, science advances human knowledge one testable hypothesis at a time. The standards of empirical research – falsifiability, reproducibility – mean that over time empirical research is self-correcting and cumulative.

Eventually, empirical evidence forms over-arching theories, which themselves can undergo change and refinement according to our questioning. Several types of designs [7] have been used by researchers, depending on the phenomena they are interested in.

The Scientific Cycle

Empirical research is not the only way to obtain knowledge about the world, however. While many students of science believe that “empirical scientific methods” and “science” are basically the same thing, the truth is that empiricism is just one of many tools in a scientist’s inventory.

In practice, empirical methods are commonly used together with non-empirical methods, and qualitative and quantitative methods produce richer data when combined. The scientific method can be thought of as a cycle, consisting of the following stages:

1. **Observation**
   Observation [6] involves collecting and organizing empirical data. For example, a biologist may notice that individual birds of the same species will not migrate some years, but will during other years. The biologist also notices that on the years they migrate, the birds appear to be bigger in size. He also knows that migration is physiologically very demanding on a bird.

1. **Induction**
   Induction [8] is then used to form a hypothesis [5]. It is the process of reaching a conclusion by considering whether a collection of broader premises supports a specific claim. For example, taking the above observations and what is already known in the field of migratory bird research, the biologist may ask a question: “is sufficiently high body weight associated with the choice to migrate each year?” He could assume that it is and stop there, but this is mere conjecture, and not science. Instead he finds a way to test his hypothesis. He devises an experiment where he tags and weighs a population of birds and watches to observe whether they migrate or not.

1.

Deduction
Deduct [9]ion relies on logic and rationality to come to specific conclusions given general premises. Deduction allows a scientist to craft the internal logic of his experimental design. For example, the argument in the biologist's experiment is: if high bird weight predicts migration, then I would expect to see those birds who I measure at higher weights to migrate, and those who do not to opt out of migration. If I *don't* see that birds with higher weight migrate more often than those who don't, I can conclude that bird weight and migration are not connected after all."

1. **Testing**
   Test the hypothesis [10]entails returning to empirical methods to put the hypothesis to the test. The biologist, after designing his experiment, conducting it and obtaining the results, now has to make sense of the data. Here, he can use statistical methods to determine the significance of any relationship he sees, and interpret his results. If he finds that almost every higher weight bird ends up migrating, he has found support (not proof) for his hypothesis that weight and migration are connected.

1. **Evaluation**
   An often-forgotten step of the research process is to reflect and appraise the process. Here, interpretations are offered and the results set within a broader context. Scientists are also encouraged to consider the limitations of their research and suggest avenues for others to pick up where they left off.

References

http://en.wikipedia.org/wiki/Empirical [11]
http://en.wikipedia.org/wiki/Empirical_research [12]

Links
[1] https://staging.explorable.com/en/empirical-research
[2] https://staging.explorable.com/en
[3] https://explorable.com/conducting-an-experiment
[4] https://explorable.com/what-is-the-scientific-method
[5] https://explorable.com/research-hypothesis
[6] https://explorable.com/scientific-observation
[7] https://explorable.com/research-designs
[8] https://explorable.com/inductive-reasoning
[9] https://explorable.com/deductive-reasoning
[10] https://explorable.com/hypothesis-testing
[11] http://en.wikipedia.org/wiki/Empirical
[12] http://en.wikipedia.org/wiki/Empirical_research