Critical Thinking & The Scientific Method

by Sophia Tutorial

WHAT'S COVERED

This tutorial will identify the basic principles that guide scientific research and determine how scientific research is conducted.

Our discussion breaks down as follows:

1. Critical Thinking
2. Scientific Method

1. Critical Thinking

Critical thinking is a way of guiding how people think within the scientific process. There are five key principles that we will discuss today; some of them might seem familiar to you from previous lessons.

- **Empirical and logical**. Scientists need to examine things empirically and logically.**Empirical evidence** refers to evidence taken from observation and experimentation. These are not things that scientists simply accept to be true or that they hear about being true; these are things that they see and therefore know to be true.

  They should be logical, in that they should be rational or reasonable; they should simply make sense. Scientists should not have to make a lot of assumptions before they understand what they are examining.

- **Falsifiable**. Scientific research should be falsifiable, meaning that the scientist should be open to and able to be proven wrong. A scientist shouldn't just assume that they are right and then not accept facts that contradict them. Alternatively, they shouldn't be trying to research something that can't be proven true or false.

- **Authority and expertise**. Authority or expertise within science isn't enough. You need to actually back up the things you know by proving them and understanding them well through actual research and understanding, versus simply assuming that because you're a scientist, that qualification is enough for everyone to accept you at your word.

- **Quality**. The quality of the research and evidence matters just as much. It's not just*what* you do within science, but *how* you do it.

- **Open-minded**. Scientists should be open-minded, which is to say that they should be able to accept new or different explanations and results, instead of relying solely on those things that they understand on their own.

TERMS TO KNOW

Critical Thinking
Thinking that is rational, open-minded, analytical, and supported by evidence

Empirical Evidence
Evidence taken from observation or experimentation, not subjective reports

2. Scientific Method

So, how do we actually determine what goes into scientific research? Well, scientific research follows a series of steps, which we call the **scientific method**. As we explore each step, we will refer to examples from an actual series of experiments in social psychology called the Asch Conformity Experiments, which are an interesting subject to research further on your own.

STEP BY STEP

Step 1: Observe and Identify. First, make observations about the natural world. You want to identify some question or area of research for your study. This is the inspiration aspect of your research, where you determine what you are actually going to talk about.

> Suppose you notice that people tend to do the same thing as a group, even if the group might be incorrect. Based on this observation and identification, you might come up with a question which asks, "Does group size affect whether somebody feels pressure to conform or to do the same thing as everybody else?"

Step 2: Formulate a Hypothesis. A hypothesis, if you recall, is a prediction about the effect of or the relationship between different things being measured within research, or are called variables. In other words, this is an educated guess about what is going to happen.

> In this case, your hypothesis might be that the larger the group of people, the more likely a person will be to conform or to do what everybody else does. Your two variables are group size and whether people conform or not.

Step 3: Research and Test. You have to create some method of research and actually test out your hypothesis. In the **experimental method**, you might create some formal trial or experiment that is done specifically to prove or disapprove your hypothesis. You could also, outside of experimentation, observe groups of people and see how often they change their behavior to match the group in certain settings, which could be an alternative to experimental method known as observational method.

You might place an individual (the test subject) in different-sized groups--small groups, large groups, etc.--and give them different tasks that the groups will purposely perform incorrectly to see if the person also performs them incorrectly.

Step 4: Examine Data. You want to examine the data, looking at the information in order to reach conclusions about it. What does the data say about your area of research? Specifically, what does it say about your hypothesis?

This is the point at which you want to either keep the hypothesis and say that it was true, or reject the hypothesis.

If your data from the group activity experiment shows that the people don't change their behavior, then you would reject the hypothesis. If they do change their behavior, you keep it. If they only change their behavior in certain sized groups, you might tweak or revise the hypothesis.

Step 5: Publish Results. With all scientific research, once you're finished with the study, you want to publish the results so that other scientists can see it. Usually this is in some professional psychological journal, like the *Psychology Review* or the *Journal of Abnormal Psychology.* This is so that others can review your methods of research and try to retest them, because remember, science should be repeatable. People should be able to do the same thing and come up with the same results.

Step 6: Propose a Theory. Finally, after many different experiments and hypotheses on this subject, you want to propose a theory, which is a summary of multiple hypotheses that is supported by the existing data and can accurately predict future outcomes.

TERMS TO KNOW

Scientific Method
Systematic way of approaching scientific questions by constructing theories that organize, test, and summarize empirical evidence

Experimental Method
A formal trial, or experiment, done specifically to prove or disprove a hypothesis

SUMMARY

Today we learned about the basic principles that guide scientific research and determine how scientific research is conducted. **Critical thinking** is a way of guiding how people think within the scientific process, and there are five key principles that apply to the critical thinking process: evidence must be examined empirically and logically; hypotheses must be falsifiable; they must be proven beyond the scope of simply relying upon the scientist's authority and expertise; the quality of the research and evidence matters; and lastly, scientists must be open-minded and open to new or different outcomes.

Scientific research follows a series of steps known as the **scientific method**: observe and identify, formulate a hypothesis, research and test, examine data, publish results, and propose a theory.

Good luck!

Source: ADAPTED FROM SOPHIA TUTORIAL BY ERICK TAGGART.

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