Episode 5-Natural Science as An Area of Knowledge

The Naïve View of Science

In this podcast, we're going to be discussing natural science as an area of knowledge. We begin with what we might call the “Man the Street View,” the or the naive theory of science, the view of science most of us carry around that we probably learned in our science class. And in this scenario, science builds upon facts kind of like bricks in a house using the scientific method. In the scientific method, as you recall, you ask questions, you do background research, you construct hypotheses, you test with an experiment, you analyze and draw conclusions. If hypothesis is true, you report the results. If the hypothesis is false, or partially true, you go back to the drawing board, construct a new hypothesis, and try things all over again, in this view, this building block view, we are ever closer to an objective understanding of the universe.

Science vs. Pseudo-Science

And we have an almost religious faith in this idea of science to objectively deliver a description of the universe. And of course, science is important, as it is our most reliable source of knowledge. Therefore, before we *deconstruct* this model of science, we need to clearly differentiate this between much of what claims to be science today. And I'm referring to here, pseudoscience. Pseudoscience would be claims that don't rely on empirical evidence, but use scientific terminology to give the appearance of science. In the past phonology was an example of pseudoscience. Today, Scientology creationism, climate change denial are all examples where they use mathematical equations, where they use statistics to advance an argument. But the argument itself isn't provable by data. Rather, it's an assumption, and they use scientific-looking terms to try to justify it. So, we don't want to fall into that trap.

Deconstructing Science

What distinguishes science is its reliance on empirical evidence. Having established what the naive or everyday view of sciences is and distinguishing it from false science or pseudoscience, now we want to go on and deconstruct the traditional view of science in order tofind out what is partial, incomplete or missing from this everyday description of the natural sciences. And today, we're going to look at the work of a man by the name of John Kemeny, who was trained as a philosopher and as a scientist. He wrote a book called *A Philosopher looks at Science*, where he deconstructs science, taking apart the naive view, and then explains, in his view, how science actually works. And basically, we're going to review the steps that he uses to kind of explain how in his view, science works, and then connect these ideas to those of Bronowski, Popper, and Kuhn to provide a more sophisticated theory of the natural sciences.

Step One: Kemeny--There is no difference between facts and theories

The first one is very radical. Kemeny denies the essential differences between the facts we uncover and the theories that we generate from those facts. He begins by noticing that the scientist has a unique perspective, because he or she lives in two worlds at the same time. One, there is the everyday world, the natural world, the world you and I share, and from which the scientists gathers observations but, at the same time a scientist is looking at that world, they are also looking for invisible connections, patterns that aren't readily available to our sense perception, and which are couched in mathematical terms. So, in his view, hard facts (which would be the opposite of a hypothesis) don't really exist. Now physical sensations exist, but when we try to explain those sensations, we always quantify them, mathematically we jump from the everyday world to the mathematical world, Okay. So, then what he says is a fact is a particular instance of event where a theory is applicable to many events. So, a fact is particular unknowable. A theory is universal but provisional, open to revision. And the difference between them is the fact that something has been observed one time that there is something that's been observed many times. Thus, there is no essential difference between a description and an explanation.

Step Two: the formation of scientific theories

He says, in order to understand that, we have to understand how we form scientific theories. Induction is the term that science usually gives for this process where you look at a sample of something dnd then from there, you use inductive reasoning to generalize that to an entire range of objects. And that's basically what theories do. Now Kemeny argues that induction is more complex than we've been led to believe. He's saying we actually we have two steps in induction: 1) you form a theory and 2) you select a hypothesis. And he's saying these are two very different acts, because the formation of a theory is a very creative process involves imagination, and intuition, where essentially, you throw out your old assumptions, and you posit a new way of looking at things--you're finding a new pattern. It uses intuition, and it doesn't always follow the facts. And then you form a hypothesis which is a different process entirely. And what he's saying is very unique. Here, he's saying, what hypothesis is, is that you've seen a pattern, you in the everyday world, you've observed a pattern. And you in your mind, you've translated that pattern into some type of mathematical relationship. So you then shop around for a mathematical formula that best describes the pattern that you've seen. Often there is more than one mathematical equation, which would provide roughly a best line of fit. And so between those, you pick the simplest one. The example that Kemeny gives of this process is looking at the discovery of the planet Neptune. Neptune was not discovered by detection or observation, as no one was looking for a new planet. However, in observing irregularities in the predicted motion of nearby planets, scientists useds their imagination to come up with a creative explanation of why these planets did not behave as predicted the insight, the creative insight was that planets behave this way,when something else was interfering with the predicted motion. In this case, Neptune. They then used mathematics to find a mathematical proposition that would predict the path of a planet between Uranus and Pluto. Once that was plotted, they could look for observational evidence of Neptune. More importantly, this theory was chosen based on a mathematical model that offered the explanation for the observed behavior, as opposed to an *ad hoc* explanation of just why these two planets in our solar system behave so radically. So from Kememy we learned that scientific knowledge is not objective in the strictest sense, but always provisional and open to revision.

Step Three: Bronowski--What is scientific certainty?

So this brings up the question of how certain are we about scientific knowledge? Joseph Bronowsk addresses this in a chapter of his book, *The Ascent of Man* entitled, “Truth or Certainty? His basic claim is that we do not ever attain absolute certainty in science. So we must ask the knowledge question, “to what degree do we have certainty in the natural sciences?” His reply to this is the Gaussian Curve--we can reduce the area of uncertainty to a small area, but can go no further, because of the imprecision in the act of measurement itself. Let’s give an example. Gauss focused on the attempt of astronomers to measure distances to stars. When people were trying to measure the distance to a particular star, no two measurements were exactly the same. However, some measurements, clearly were wrong. They were simply not close to the other measurements, and so were discarded. What remained were a cluster of measurements that they deemed accurate. And he drew a kind of bell-shaped curve around those, and that is called the famous Gaussian curve. And what he says is, that we know with certainty, that the position that star is somewhere in this range, but no matter how sophisticated our instruments, we're not going to get closer to that one singular accurate measurement. The idea is there is always a range of uncertainty within knowledge: you can be certain to a defined area of uncertainty, that is the Gaussian curve. But beyond that, you can't any more certain. Thus he asserts the idea science always has a degree of uncertainty, and is therefore is open to revision. His basic claim is that we do not ever attain absolute certainty in science. Taken together, Kemeny and Bronowski advance the argument that science can only provide a range of certainty. This means we need to reconsider how the scientific method actually works. It's not the building block theory that the naive view of science advocated.

Step Four: Popper—Science and Falsifiability

Karl Popper introduced the concept of "falsifiability." Building upon Kemeny's idea that we never can really disprove a theory because of the many variables involved and the difficulty of producing a singular truth. Perhaps the goal of science is not to prove, but rather to try to falsify claims: then whatever is not falsified is taken to be provisionally true. In essence, induction of the traditional scientific method is replaced by falsifiability. Science then is not a static process of building blocks of facts into theories. Rather, it's trying to come closer to the truth by disproving existing theories. It's a prohibitive approach. What distinguishes science from other disciplines is that it claims to have to be falsifiable, that is, there have to exist clear conditions under which claims will be considered true or false.

Step Five: Kuhn—How Science Works

The new understanding of science introduced by Kemeny, Bronowski and Popper all point to a more sophisticated and dynamic view of science as an area of knowledge. The question of how knowledge is structured in science is the topic taken up by Thomas Kuhn. In his *The Structure of Scientific Revolution*, Kuhn argues every scientific viewpoint rests upon a set of assumptions about the world, which guides inquiry, Kuhn calls the set of assumptions, a :paradigm." An example of a paradigm might be Newton's view of the physical world, and its insistence that space and time are absolute constructs. When relativity theory came along, these facts were rejected, and space and time were shown to be relative. Thus, what counts as a fact is dependent upon the *contex,* that is, on the paradigm being used and the assumptions that this paradigm makes regarding the world. Science according to Kuhn advances by investigating the implications of a given paradigm. For most of the lifespan of a paradigm this involves *ordinary science*, examining the implications that result from this set of specific assumptions. At some point in time, however, the search is no longer successful. As we find anomalies, things that just don't fit the paradigm pattern, science is thrown into a state of disarray until a new paradigm, a new set of assumptions, is adopted, and these allow us to understand the anomalies. The conclusion is that facts ultimately, were dependent upon the paradigm in which they were created for their meaning. Thus, scientific progress is the development of successive paradigms, each telling us something about the world.

Summary

At the end of our review, a number of things about science become apparent.

1) Science is not a purely cumulative event, building one set of facts upon a previous
2) The act of scientific discovery is a mixture of intuition and mathematical models that tries to map out the pattern intuited

3) The attempts to describe the world mathematically are always provisional, we can only be certain to the point of the Gaussian curve and no further.
4) Given this provisional nature, perhaps it's more useful to see science as the attempt to falsify knowledge claims with whatever resist the falsification taken to be provisionally true.
5) This provisional nature of knowledge shows that ultimately, all scientific claims, all scientific systems of knowledge themselves rests upon a series of assumptions about the world. When the assumptions paradigms change. What we learn about the world changes facts themselves exists within the context established by the paradigm.

This is not to deny that science is not the most certain area of knowledge. It is the most certain because the things that studies are all subjected to cause and effect. It is, however, to assert that science is a more creative and less certain sphere than previously thought. Many of the structural ideas that we've developed about science natural science can also be found in other areas of knowledge.

Thank you