2011

Reflections on Science

Ken Smith
Parkland College

Ken Smith – Honors Seminar - Reflection paper.

What is purpose of science? -*The purpose of science is to understand the processes and functions of natural world around us.*

Even after reading Chalmers I still think this is an acceptable definition. While Chalmers shows that the complete process is actually far more complicated and has many individual steps, and much of the detail is done automatically even without individual awareness. Science is both, finding the raw data which lead to statements of fact, and the process itself by which we arrive at these statements.

How is science done? -*Science is achieved by making initial observations. These observations can be both quantitative and qualitative in nature and are often observed over a period of time to note changes. For qualitative type events, recorded data is of a descriptive nature, and can describe a variety of characteristics, such as color or scent. For quantitative type data, measurements are taken. These include dimensions, masses, times, forces, charges, light intensity, temperature, and many others. Once a suitable amount of data is collected, an analysis is performed to try and find a relationship or pattern between the data.*

Originally I said that initial observation is the beginning of how science is done. In the first chapter of Chalmers we discover that is not entirely true. In reality a person must know quite a bit about the subject they are investigating long before they make any observations so that they can make useful conclusions after the observation. This is part of the extra individual steps that one wouldn't normally consider as part of the process. Chalmers gives an example of a biology fieldtrip where the observations of a non biologist are compared to those of a veteran. He illustrates that the trained biologist will be "capable of collecting facts that are far more numerous and discerning" (12) than the untrained. His reason for this is simple. The biologist has a "more elaborate conceptual scheme to exploit because he knows more botany."(12) Therefore, at least some foundational knowledge of the subject is required in order to make observations that can be formed into useful factual statements. While this idea may seem profound at its reading it really shouldn't be a surprise. With any investigation an inventory must be taken to decide what is known and what is unknown. Where does the boundary of existing knowledge exist? Once that is decided or determined then one can proceed. Much like reading a map, in order to use directions to get to the destination, one must first identify the current location. This seems so obviously true, and often done automatically, that few even think of it as a beginning step. In the same way, when trying to extend the knowledge boundary, we must first identify and clearly understand our current state of knowledge. Chalmers states, "Our search for relevant facts needs to be guided by our current state of knowledge."(13) Clearly, only someone trained in a specific discipline will be able to say for certain where that current boundary of knowledge is, and only he will be able to decide which relevant questions to ask to extend the boundary of knowledge.

What is a theory? -*Once data is collected and a pattern or relationship emerges, those studying the event can make predictions based on the patterns. After predictions are made, researchers can go and observe more events to find data that fits their predictions, or they can perform experiments to test for the specific data values they are interested in. In essence, a theory is a guess or prediction for a physical event based on observed or experimental data.*

If I was ever confused about what a theory actually is, I think I am more so now. In discussion we explored this mystery, and again, according to Chalmers, the actual version is far more complex than people initially expect. A theory is a fallible statement describing some event or outcome, and it is also the result of inductive reasoning. However for this theory to be tested one uses deductive arguments. As a result, a theory is sandwiched between inductive and deductive logic. (54) Initially there was confusion between induction and deduction, but induction begins with a specific observable event that displays evidence of a pattern or relationship. From this pattern a proposed hypothesis can be developed, and after comparing with the observed data, can be expanded into a general conclusion about that kind of event. Induction is specific to general, specific observable event verbalized in a general factual statement. Deduction is the opposite. It takes a general statement of fact, which is then refined to describe proposed behavior, and then compares these with a specific observable event. This outcome then either confirms or refutes the initial general statement of fact. Chalmers puts laws and theories in the same point in the scientific development process. He puts both in between the inductive and deductive logic. This suggests that there is little difference between the two, but in all our experience and study we are consistently inundated with the idea that they are indeed very different. To resolve this I propose the graph needs additional mapping. If a path from "predictions and explanations" lead back to theories labeled *non supportive results,* this would keep a theory a theory. But another path labeled *supportive results* would allow and idea to advance towards the status of law.

What is a law? -*Once information from random observations, or purposely designed tests confirm the predictions, the experiment which illustrates the theory must then be repeatable. Many times repeated tests or experiments will yield different results. These differences are recorded and modifications are made to the theory. Eventually the experiments result in the same result time and time again. Theories that are explained by experiments that can be repeated by anyone anywhere producing the same results are termed laws.*

Originally I must admit a bit of uncertainty as to when and how a theory *became* law, and the mysterious voodoo behind it. Particularly, when is something proven to be true? When it stands the test of time? When consistent results come from some magic number of successful experiments? Is it a law when it can successfully predict experimental outcomes? Perhaps when observed behavior is completely explained, then theory becomes law. In discussion we said that a scientific *law* is best thought of as a combination of these elements. First, in order for a statement to be *true* it must always be so, meaning it is consistent and repeatable, and time is required for these to develop. Second, as technology improves, observations, measurements, and experiments become more accurate allowing us to see, quantify, and test in more detail, which leads to more precise explanations of observed behavior. Again, time is required for these to happen as well. Third, with technology advancements some experiments may disprove an idea because new evidence is discovered. In the absence of such experiments, however, our understanding does indeed develop a predictive character. Even if all this is true, does this *prove* our scientific statement true so that it then becomes scientific law? From discussion we kept alluding to the fact that you cannot really *prove* anything, but you can easily disprove something since only one counter example is needed. In discussion I compared scientific discovery to walking through a maze. Reaching the end is equivalent to knowing without doubt some statement of scientific truth. On the way there are many walls that block our path and we are forced to alter our direction. Walls that block our path are equivalent to experiments with non supportive or even contradictory results. We cannot ever directly prove something true, but we can narrow our search by eliminating false statements. In this way, like traveling through the maze, we must change our thoughts in the presence of evidence that disproves our current thinking, or keep looking when there is no evidence at all. Notice also, that when redirected in the maze one might actually be traveling away from the goal rather than towards it. In the same way redirected thinking may lead us towards a dead end, as often happens in scientific research. While there are many specifics that describe what a law is, all of them need time to develop. For that reason, while it is a simplification, standing the test of time, is really the simplest answer so long as one understands all that this entails.

How is research done? -*Research is done by first stating an objective and identifying what is it you are trying to determine. Observations or experiments are performed to see if patterns exist. These patterns are often compared to known information to see if correlations or contradictions occur. Care must be taken when testing, experimenting, or computing results that data is accurate and unbiased. This is an essential part of the research process.*

When I originally stated “observations or experiments are performed to check for patterns,” I stated that as if it were a very simple and well understood process. In Chalmers we see once again that this too is not quite so simple, and therefore not so commonly understood. Initially it is suggested that observations are passive, but really, in all but the strictest sense, is not the case. Indeed the act of observing involves many actions. Chalmers states “there are a range of things that are done, many of them automatically, perhaps unconsciously, to establish the validity of a perception.”(19) Anyone that’s been in a hall of mirrors, or witnessed any type of optical illusion can attest to this fact. When presented with the image on the retinas, either intuition or gut feeling, may suggest that reality is somehow different, and that our eyes are playing tricks on us. Indeed an almost involuntary response to touch or move to an alternate view of the object or scene takes place. In actuality, we may interact with an event in many ways to validate our observations. Is this real? Is this really what it appears to be? These are the questions our mind asks and answers continuously, and often quite unconsciously, so the instinctual responses to stimuli are usually perceived as passive. While these actions might be considered interactive they might not be seen as manipulative. Often these

passive non manipulative tests for validity do not present the results sought after. In many cases there are multiple influences on the observation we perceive that cannot be distinguished by these tests alone. To better understand these influences and determine their effects we must "practically intervene to try and isolate the process under investigation and eliminate the effects of others…*and*…do experiments."(28)
How do scientists come to conclusions in their field? -*Once the research is done and the data collected and the theories are repeatable with a high degree of accuracy, by many people, in many situations, a scientist may attempt to disprove his results. If no further changes occur and this attempt proves unsuccessful, this experiment can be summarized and formulated into a conclusion.*

Again, my simplified explanation leaves out many details. No one would call science the art of collecting numbers. While taking measurements is a type of data collection, it is still not science. In the same way observation alone is not science. A museum spectator is not doing any scientific work. . Indeed Chalmers says "it is absurd to think that statements of fact enter the brain by way of the senses."(11) Rather it is the observations, which are collected as data, the process of analysis, and the creativity of the researcher together that allow scientists to come to conclusions. When compared to building a home, if the data and observations are the raw materials, and the tools are the scientific process, these alone do not build a house. In the same way data and analysis do not create scientific statements of fact. There still needs to be a creative driving element behind it all to keep the process going and to make course corrections when necessary. After all, many different types of homes can be built from the same set of tools with the same materials. Again, what is the researcher after and how does he go about finding it, this is also an equally important element of how scientists come to conclusions.