March 4, 2014

Science Explained

Graham H Pyke

What really is science, and the process whereby science is produced? Answering this question is fundamental to understanding and appreciating how science is incorporated into our lives. Its consideration is also essential to evaluating criticisms that have been made, especially recently, with regard to both science and scientists. I here attempt to answer this question.

Science has three inter-related aspects, observation, understanding, disagreement and communication. Science begins with observations, such as when you drop an apple it falls to the ground or the sun may be daily observed to move visually across the sky from east to west. The next step, naturally enough, is an attempt to understand the observed phenomenon in terms of underlying mechanisms and processes. Finally, it really doesn't count as science unless both observations and understanding are communicated to the world at large.

Observations are, of course, context specific and strongly influenced by available technology, and may lead to detected patterns. Aristotle, for example, was able to observed the foraging behaviour of bees and noted that these bees were generally 'constant' to particular plant species, tending to move between plants of a single species, and bypassing suitable plants of other species. And he did this in about 350BC, without any technological aids. Contrast this with the Higgs Boson particle, a particle that was hypothesised to exist but could not be detected until the necessary large, complex and expensive machinery was recently developed. Though few of us are able to make observations relevant to the Higgs Boson, or other elementary particles, we can all observe the world around us, in much the same way as Aristotle. Hence, we are all potential scientists!

Developing an understanding of observed phenomena is achieved through an iterative process involving explanation, prediction and further observation; this is the next aspect of science. An appealingly simple explanation for the observed 'movement' of the Sun across the sky was that the Sun revolves around a stationary Earth, and this was indeed the originally adopted explanation. From such an explanation, predictions are made concerning new observations that

can be made, and then these predictions and observations are compared, with discrepancies between the two generally requiring a 'back to the drawing-board' approach, successively attempting to find increasingly improved agreement between observed and predicted. This is science at work!

Obvious outcomes of this scientific process are that 'revolutions' may occur and science never really ends in certainty. For example, astronomical observations eventually proved too much for the geocentric view of the universe, with everything revolving around a stationary earth, and it was replaced with the fundamentally different heliocentric view of our solar system, with planets and other bodies revolving around our sun. But this was not the end of it, as neither our sun nor earth are stationary, but instead are apparently part of an expanding universe. And so sciences continues, essentially ad infinitum.

Thus, as science progresses and disagreements between observed and expected generally decrease, our understanding of phenomena increases and, with it, our abilities to use science to inform our decisions and actions. These days, one has only to look at our transportation systems, appliances and other gadgets, electronic gear including computers and the like, and our health system with medicines, medical tests and associated programs, to see the outcomes of science put into use.

On the other hand, the scientific process is such that there will always be disagreement among scientists; this is also fundamental to science. It is natural, as part of testing predictions in new and different situations, to try to challenge current wisdom. Obviously, the greater are the challenges successfully fended off by an explanation for observed phenomena, the stronger and more useful is the explanation. In fact, the academic system, within which scientists are generally employed, rewards those who can point to a need to modify an explanation and then provide the necessary revision.

Also fundamental to science is communication between scientists and the rest of the world. Unless such communication occurs, the relevant science can hardly be acknowledged, appreciated and utilised. Put simply, science that is not communicated is not really science, and remains consigned to oblivion.

This account of the scientific process omits many relevant issues. Most importantly these include evaluation of research quality, the processes by which the results of science are communicated, as well as how, where and by whom these activities are carried out. I shall attempt to further address such issues in subsequent posts.

The above description of science, and how it works, should provide a basis for considering the many issues associated with science.

For now this is my version of science explained!

MAHB-UTS Blogs are a joint venture between the University of Technology Sydney and the Millennium Alliance for Humanity and the Biosphere. Questions should be directed to joan@mahbonline.org

MAHB Blog: http://mahb.stanford.edu/blog/science-explained/