Outline - TOK Science Presentation: Scientific Epistemology

Thursday, November 1, 2018

1) Kuhn's Normal Science
    a) What I did for my own research project – speciation and fluxes of Zn- and Cu-complexing ligands
    b) How "the process" works
        i) Funding
        ii) Research
            (1) Ideas lead to reading, reading leads to ideas
            (2) Hypothesis
            (3) Experimenting - learn the technology (e.g., cathodic stripping voltammetry)
            (4) Communicating - communicate with your adviser
            (5) Experimenting - collecting data
            (6) Communicating
                (a) Defend the thesis
                (b) Publish the thesis
        iii) More funding (an important part of Latour's views of what gets studied, what gets published, and therefore what gets discovered/known)
2) No science without a scientific community
    a) According to Jonathan Rauch's book, *Kindly Inquisitors*, the scientific community is how new knowledge is generated; individual scientists working in isolation do not make new knowledge.
    b) Jonathan Rauch, a big believer in the power of community in the search for knowledge. Supports a pretty radical view of harnessing the collective power of all ideas, even ones he disagrees with:
        i) "I tell people that hate speech laws, suppressing speech that's wrong-headed and hateful is like curing global warming by breaking the thermometers. The root problem is fear and ignorance and hatred, and you go for that by correcting people."
        ii) "Knowledge is like finding a needle in a haystack because it's so hard to get. And the only way you get it is to harness everyone to the task of looking through the haystack by putting everything out there, and then putting everyone to work criticizing and sorting."
    c) The court of the scientific community
        i) Note that science can be political - Deccan volcanoes and Keller vs asteroids and Alvarez
        ii) Feelings get hurt when critics are unnecessarily mean
        iii) And feelings still get hurt when people are polite - there are winners in losers in science
    d) Members of the community cannot under any circumstance
        i) Lie, which is bad
        ii) Spread B.S., which is far more injurious (Harry Frankfurt)
            (1) Lies and B.S. permanently injure the community
3) Evolution, or Revolution?
    a) Evolution: "If I have seen further than other men . . . ."
        i) Note about giants, Hooke, and being polite: dwarfs, etc.
        ii) Newton was an alchemist (". . . not the first of the age of reason but the last of the magicians." - JM Keynes), spiritual, religious.
        iii) Newton did not work in isolation - a member of the community. The idea that he was a lone genius is not accurate.

b) Karl Popper, falsifiability, and evolution through the elimination of lousy theories
    i) The community is the referee
    ii) The problem with assigned SAT vocabulary words - a theory that was unfalsifiable
    iii) The problems with induction, and how the past cannot predict the future
        (1) Russell's chicken
    iv) Popper would suggest that new discoveries and unexplainable data would require theories to be re-worked. But in reality there is a shameful history of anomalous data being thrown out because it does not agree with accepted theory (Feynman: "a thing that scientists are ashamed of"). Example: the evolution of the charge on an electron in the wake of its discovery by Millikan. Throw out data too far from the "wise man's" value, but keep the data close to the wise man's value.
        (a) "The difference between a scientist and a prophet does not lie in what the great man says but in how it is received. The duty of the pupils of a scientist is to test his theses by looking for evidence to refute them, while the duty of the disciples of a prophet is to go on repeating his very words." – Joan Robinson
c) Kuhn's paradigm shift and scientific revolutions

4) Kuhn's revolutionary Science and the problem with scientific revolutions
    a) Thomas Kuhn: *The Structure of Scientific Revolutions*
    b) Kuhn said that the generation of new scientific knowledge was not a smooth evolution but a lurching series of revolutions.
    c) Paradigm, anomaly, crisis, revolution, new paradigm
        i) You can't really interpret what you cannot observe
        ii) The technology has to be there
        iii) Certain ideas are within the paradigm and can be explored. Others that are outside the paradigm cannot be explored. They are not just considered wrong, they are "not even wrong." They are not even considered until enough anomalies pile up.
        iv) What good would the theory of relativity be to the folks of 400 years ago, when they had no data or experiences at the time that would remain unexplained without such a theory? If there is no need for such an explanation, would they consider such an explanation? A solution in search of a problem.
            (1) The ultraviolet catastrophe & Planck's idea of quantization
            (2) The modification of the periodic table (atomic mass, atomic number)
            (3) So, if Newton could not observe (or detect, or measure) objects moving near the speed of light, were his laws of motion still "correct"? If they could adequately explain everything that he could observe, were they "correct"? Since they do not explain everything that is observed/is measurable today, are they "incorrect" today? What if the barrier to observation is not just technological, but the fact that a theory is too far outside the pale (the boundaries of acceptable science) for consideration? Let's assume that scientific discoveries will continue to be made into the future. Are our currently useful theories and scientific ideas "correct" today when it is extremely likely that we will be considered ignorant by the standards of next century?
            (4) Mining operations in Kimberly, Australia will never produce a large diamond, because they refuse to "look" for such a thing with their methods (crushing to a certain diameter). *By design* they will never find such a stone; *by design* current scientific paradigms must exclude certain ideas.
        v) Popper would say that new and exciting data would be immediately used to modify theories. Kuhn says that such data would be rejected as anomalous - ignored - until the anomalies resulted in a crisis, and then a revolution

vi) Transgressing the paradigm
(1) Boltzmann - right but called wrong.
(2) Avogadro - right but called wrong
(3) Gregor Mendel - right but ignored
(4) The evils of Lysenkoism

5) The problem with science - do we discover facts or construct them?
a) A tale of observer-influenced reality: Asst Mgr Ron and the word, "condiments."
b) Latour and "constructed facts"
i) His experiences in Ivory Coast
ii) African executives were hard to develop
iii) It was presumed to be due deficiencies in the "African mind."
iv) Latour thought that the students were prepared inadequately
v) If European outsiders can study "the African mind," then what if a non-science outsider studied "the scientific mind"?
vi) Result: *Laboratory Life: The Construction of Scientific Facts*
(1) Personal thought: it's probably a good idea to turn the lens back on the scientists from an outside perspective, even if I don't completely agree with the aims and conclusions of *Laboratory Life.* As Bernard Lewis stated about the ability and value of an outsider to study a subject, "If Westerners cannot legitimately study the history of Africa or the Middle East, then only fish can study marine biology."
c) What I believe
i) Scientific knowledge is dynamic
ii) The community is the referee - our knowledge is only as good as our community is critical and open
iii) "New scientific knowledge": its generation is to an extent the construction of the experimenters themselves, but boy those vaccines - and other products of our "flawed" empirical system of science - sure do work well! :)

6) Closing thoughts