JON JACKSON
University of North Dakota

Using Observational Data to Establish What is "Normal"

A Vexation:

As a scientist, I am filled with grave concerns about public scientific literacy, and as an instructor, my day-to-day routine abounds in justifications for pessimism about the comprehension of the nature of science by undergraduate students in our school's science and health profession major departments. Beneath this 'cheery' veneer, I am vexed by the lack of time spent in observation of **any** phenomena, scientific or otherwise, by today's students — either as part of a formal lab course or in discussion groups during lecture courses. [Now is when I'm expected to say something along the lines of: "In my day. . ."]. In my view, one unintentional consequence of this lack of time spent observing and documenting one's observations is a lack of the sort of critical descriptive skills that formed the underpinning of so much modern science, biology in particular. Think of Darwin's theory — according to the popular account, what if Chuck hadn't been able to discern a difference in beak sizes among the finches?

If you take (on my word) that critical descriptions of what is observed in even rather mundane settings is a vanishing skill, then re-engaging students in this manner, to develop this skill, as a sort of pedagogical 'ontogeny recapitulates phylogeny' of science, could only help to get them to better understand populations, normal variations, and real differences. But how to do it? The real vexation rears its head and bares its teeth.

As a teacher of human gross anatomy to undergraduate students, my course has an associated lab component wherein the students need to pick, poke and prod their way through cadaveric specimens to learn the important physical landmarks of the osteological system, the urinary system, the respiratory system, *etc*. There is little formal attention given to the normal human variation component during these explorations — and as a result, there are a significant number of students who'd rather not "get their hands dirty" and physically explore the body on the table. I have all manner of anecdotal information (and here I'm reminded of a quote from Alan Magid, a physiologist in Durham, NC: "the plural of anecdote is ***not*** data") that suggests that students who leave these laboratory sessions without formally investigating some definite question, (*e.g.*, how many lobes are present on your cadaver's liver?) do worse on lab exams than those who frame and answer these questions for themselves. I wish to change how we think of the cadaver lab experience to incorporate a more "investigative" approach to the descriptive biology of what is going on in lab, an approach that lends itself to teaching the nature of science through doing observational work of science.

A Venture:

The body consists of some 35 or so discrete organs — when added to a long list of muscles and bones, the list of identifiable structures comprises roughly 500 items (for non-medical gross anatomy). From this list, I want to try and take the most familiar, the most clinically "likely to be involved in your life" items, and have the students measure them: weigh them, determine their length, and describe any 'noteworthy' features of these organs.

A friend and colleague, Chris Eckel, from Salt Lake City Community College (and a PhD student at the University of Utah), has utilized as part of her dissertation research an "autopsy worksheet" designed for use by first-year medical students in the gross anatomy course. I have adapted the worksheet for use by senior undergraduates in a directed studies course, but now seek to utilize one or more features in the large undergraduate laboratory course I direct.

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The salient feature of this worksheet is the acquisition of measurements from the laboratory specimen — something that calls for direct observation and physical contact — it is a small step from these measurements to asking students to postulate whether what they're observing is "normal" or not, and if not, having them formulate a hypothesis as to what pathology underlies the non-normal state of the organ in question, say the liver.

Adam and John invited me to use some of the more well-known accounts of famous scientists being forced as students to observe (closely, completely and maddeningly) a specimen for days on end, only to be asked the simple question by their instructor, "what do you see?" Such singleness of purpose is to be admired, presumably—but in the case of both of these students (whose instructor was Louis Agassiz, about whom I offer more later), on their later reflection from their respected positions on the faculty of Harvard College and from the U.S. Geological Survey, the week spent along with the *Haemulon,* known more commonly to us as the grunt fish, was the single formative experience in their scientific careers. John pointed me toward an article I hadn't seen since the weekend it came out in the New York Times Magazine, called "Buried Answers," a lament about the declining rate of autopsies generally, and the impact of this decline on medical care.

If we don't observe, how can we truly know? It seems rude to paraphrase Aristotle and the apostle Thomas so roughly, but that is the essence of their clamor to us. If so much of our enterprise depends on our detailed knowledge of things, how best to acquire the needed knowledge except through observation. If the rate of wrong diagnosis in American health care hovers around 40%, and if, as the Institute of Medicine suggests, more people are injured through medical mistakes than by automobile accidents, we as citizens should demand more observation from our health care system. Autopsy, which comes to us from the Greek "to see for one's self," should rank among the most noble of medical procedures. (And if our culture placed that kind of value on knowledge for knowledge's sake, we'd be having these conferences in the Virgin Islands, but I digress…) Those who lament the declining reliance on our own senses to distinguish what caused a patient's death, in place of trusting MRI machines, CT scans and the like, share with Aristotle, and with Agassiz and his academic forebears, a distrust of the received wisdom, regardless of its source, and a higher trust in the clear view of our senses.

Agassiz himself was the "academic great-grandson" of one of the first physicians to systematically perform autopsies, Giovanni Battista Morgagni, who is widely acknowledged as the father of clinical pathology. In the case of Agassiz's student Nathaniel Shaler, the close and attentive observation demanded by Agassiz was a rite of passage as much as it was an integral aspect of the kind of attention to detail and skilled questioning that was demanded of him by his discipline.

I have hesitated in taking this tack with my large undergraduate lab course because the amount of material these students must grapple with is already quite large. I am currently ready to justify such an exercise on the grounds of this new activity would ask them to work at a different level of understanding and interpretation than mere rote memorization of bony landmarks and muscular attachments. This venture puts me personally on unfamiliar footing — within "hard core science" disciplines, it seems to me that such education as one receives in the nature of science is part of an invisible curriculum. Trying to implement such an effect in an undergraduate classroom my see me making a leap from pedagogy to faith — a leap I am loath to make, even with a safety net. So I ask — is there a pedagogical basis for this type of activity in the curriculum? I sense and believe that this measuring exercise will yield benefits to my students, in the realm of better understanding of human anatomic variation and the commonality of humanity as well as in the nature of science.