Philosophy

I have been teaching professionally at the college-level since 2005. Formal education in teaching methods and pedagogy was not part of my graduate-level schooling. Most of how I teach today is therefore a mosaic of techniques that are borrowed from, or inspired by, my own past teachers. I see every lecture as an opportunity to justify my own personal interest and investment in the subject before a potentially skeptical audience. Teaching is therefore not simply an exercise in sharing my knowledge, it is a deeply personal apologetic. Given all else, it is most important to me that my students walk out of my class knowing that I absolutely love the subject matter that I teach, AND that they should as well.

Science is Relevant.— I strongly believe that judging the value of the pursuit of knowledge solely by its applicability to affect social change undermines the very essence of scientific pursuit. First, it ignores the history of science, which is full of examples where initially "non-utilitarian" studies and ideas, turned out to be of great social and economic benefit, or served as the founding work of entire new fields of study (e.g. Charles Darwin's "useless" opus monograph on barnacles was key in shaping and developing his ideas on natural selection and evolution after he returned from his global voyage). Second, limiting "worthy" knowledge to that which is expected to immediately affect today's social and environmental challenges imprisons science in the present, and reduces discovery to established lines of inquiry. Third, to undervalue the seeking of knowledge for simple personal growth, depth, and experience, ignores the very essence of human nature: the ability to be swayed, inspired, and driven by abstract concepts and ideas, the meaning and value of which is solely attributed by the individual. My teaching emphasizes the historical fact that new discoveries and groundbreaking scientific ideas, including those who have led to major revolutions in medicine, economics, and social justice, would not have garnered much support by society at the time. Furthermore, I argue that individual passions and non-utilitarian ideas are fertile ground, and should be supported as such, for innovation and scientific discovery. George Lemaître, who first proposed that the universe was expanding (e.g. the Big Bang) was inspired and motivated by his studies in theology and his religious beliefs. Charles Darwin's original passion was spent (perhaps excessively, as he admitted) on the shooting range (a skill that later served him well on his "collecting trips"), as well as on collecting beetles, pondering poetry, and reading travel logs, biographies, and popular works of fiction. I want my students to contemplate how history, specifically scientific progress, would have been different if Lemaître had been told that his pursuit of theological studies was "not in the immediate interest of society", or if Darwin had been turned away from his "useless" pursuit of an ever growing beetle collection, to become a country vicar instead (although one might lament the fact that he probably would have made a wonderful country vicar!). I truly believe in the importance of a liberal arts education, and my teaching is "liberally" sprinkled with historical examples of scientific genius and progress that either found little societal support at the time, or would find little to no societal support today (indeed such examples are, unfortunately, the norm, not the rule). Judging the merit of scientific pursuit based solely on contemporary economic or social needs is antithetical to the growth of human knowledge. I believe my philosophical approach not only makes science more approachable to students in the humanities and arts, but also creates a learning environment in which students are safe and feel free to ask "dumb", "irrelevant", or seemingly "unrelated" questions about the subject matter at

hand. Questions that can reveal misconceptions, or misunderstanding, and often serve as stimuli for deeper discussion. I am deeply convicted by the idea, that when the mind is able to freely roam and imagine creatively, unimpeded by contemporary constraints and limitations, that science and learning, is at its strongest.

Science as a Narrative.--I have always loved and valued story-telling. My German upbringing in a culture that regards the Brothers Grimm's "mere" fairy tales as irreplaceable morality tales, and elevates fictional literature as means to explore the human condition (e.g. Goethe, Storm, Kafka, Mann, Brecht, Fritsch, Schiller, Hoffman) to a nearly equal footing with modern psychology and sociology, has left me predisposed to the lure of conveying information in the form of a narrative. I suspect that, story-telling, the means by which extensive human history and culture, has been effectively preserved and passed down through the generations for thousands of years before the written word, might have something to offer regarding learning and retention. I believe that rather than teaching disconnected facts and ahistorical scientific conclusions, conveying how science has progressed is best done as part of a narrative. A "good story" must have an innocent beginning (e.g. how did geologists explain the surface of our planet before plate tectonics?), relatable characters, (e.g. Alfred Wegener, Harry Hess, Marie Tharp), with personal motives and sources of inspiration (e.g. who were the scientists as people and what made them "tick"?), a slowly-building accumulation of story and plot (e.g. the cultural context of WWII technology and research; the Cold War and how this contributed to the formation of the theory of plate tectonics), and a final crescendo and not-entirely-predictable outcome (e.g. the surprising extent to which the theory of plate tectonics has revolutionized the earth sciences). Many of my lectures are divided into a series, or chapters, of such narratives. These can range anywhere from 5-20 minutes in length. In good story-telling tradition (!), and to support retention and learning, I have students retell the story to a partner in class immediately following my narrative. Students get immediate feedback on how much of the material they have understood and what parts they might have overlooked.

Science as a Way of Knowing.—The challenge to educate students about current scientific consensus and the process of science is always growing. With an ever-expanding internet of readily available resources, students are increasingly exposed to the claims of pseudoscience, and a bewildering array of incomplete, misleading, and outright false critiques of the mainstream scientific consensus. Climate change denial, anti-evolutionism, the anti-vaccination movement, forbidden history conspiracies, and homeopathy[1] are only the most visible branches of this tree-choking vine. This phenomenon has shaped the way I teach in two important ways:

First, I have reduced the number of topics, that I cover in my introductory courses where enrollment is dominated by non-science degree students. The strategy is to have them understand a few important concepts well, rather than have a superficial understanding of a lot of disparate concepts. Whenever possible my approach emphasizes processes and concepts over terminology

[1] Although homeopathy is popularly equated with off-the-shelf "natural" and "alternative" supplements or medications, the claims of homeopaths lie rooted in the 18th century teachings of Samuel Hahnemann. In application, homeopaths prescribe remedies that are essentially pure and simple water, which allegedly carry only the mysterious "essence" of the affecting cure.

and definitions (geology especially being a gluttonous smorgasbord of terms), although the latter are the essential vocabulary of the language of science.

Second, my teaching emphasizes the methodology of scientific inquiry. Whenever possible, I reconstruct the processes of hypothesis testing, experimenting, inductive and deductive reasoning, prediction, and retrodiction that have led to any given scientific explanations. All the while, I stress the difference between knowing what is true and having knowledge based on unfalsified hypothesis, justified inferences, and repeatability. Explanations are only deemed "scientific", when they work, lead to testable predictions, are able to repeat the phenomenon at hand, and are justified by evidence. As long as these requirements are met, the explanation is part of the realm of science, regardless of whether it can be deemed "true" in the absolute sense of the word. An explanation is not considered "scientific" because most scientists think it to be true, but rather because it meets the rigorous methodological criteria of scientific inquiry. I stress the fluid and open-minded nature of true scientific inquiry – always open to change, discard, and adapt based on new evidence or arising uncertainties. I use the conceptual definitions of hypothesis, fact, law, and theory as recommended by the National Academies of Science and Institute of Medicine[2].

[2] See *Science, Evolution, and Creationism*, National Academy of Sciences and Institute of Medicine, National Academies of Science, 2008.