COLLEGE WEEK

College Makeover

The matrix, revisited.

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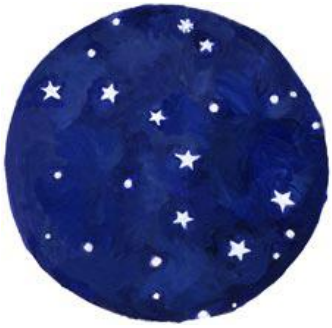
What should students be studying in college? No one seems to agree anymore. ***Slate*** *has taken the occasion to ask an array of prominent academics to tackle the question at the heart of this debate. Click here to read more from our symposium on reinventing college, and here to read more from* ***Slate****'s "College Week."*



General science education, often an afterthought, needs to be reconsidered, because scientific literacy is more important than ever. It's not just essential to being a competent citizen who can understand, for example, why hydrogen fuel cannot solve energy shortages, or that a child who swallows a pencil lead will not get lead

poisoning. Science is also critical because it is blending with the other realms of human knowledge.

One example is deep history— the study of the peopling of the earth, the diversification of languages and cultures, and the transition from foraging to farming and civilization. Deep history, popularized by Jared Diamond's *Guns, Germs, and Steel*, is unifying the timeline of biological evolution with the timeline of human history and culture. Another example is the sciences of human nature, such as cognitive neuroscience, behavioral genetics, and evolutionary psychology. They are illuminating the mental processes that go into creating and appreciating art and that drive the social contracts underlying economic and political systems.

More generally, the discoveries of science have cascading effects, many unforeseeable, on how we view ourselves—for example, that we are a species of primate that has existed for a tiny fraction of the history of the earth, and that precious and widely held beliefs, when subjected to empirical tests, are often cruelly falsified.

Conventional introductory courses will not impart the necessary appreciation. Though knowledge itself increasingly ignores boundaries between fields, professors are apt to organize their pedagogy around the methods and history of their academic subculture rather than some coherent topic in the world. Science courses should thus be organized around content rather than discipline: the physical universe, rather than physics or astronomy or chemistry; living things, rather than biology; the human mind, rather than psychology or neuroscience.

Cognitive psychology has shown that the mind best understands facts when they are woven into a conceptual fabric, such as a narrative, mental map, or intuitive theory. Disconnected facts in the mind are like unlinked pages on the Web: They might as well not exist. Science has to be taught in a way that knowledge is organized, one hopes permanently, in the minds of students.

One possibility is to use time as a matrix. The big bang marks the origin of the subject matter of physics; chemistry came into being with the cooling of the young universe and condensation of elements; the formation of the solar system and earth inaugurated geology; the emergence of the first life brought forth evolution and molecular biology; the successive appearance of complex cells, multicellular organisms, social organisms, primates, and our species each provided an excuse for a new branch of biology. And with the advent of deep history, a

chronologically organized science curriculum could naturally segue into an updated "Western Civ" sequence on world history, civilizations, and ideas, potentially unifying an entire general education curriculum.

Another major discovery of cognitive psychology with implications for general education is that the untutored mind is prone to systematic fallacies and biases. Most physicians, for example, make whoppingly inaccurate estimates of the probability that a person has a disease given a positive test result and the disease's base rate. The mind seems to have trouble grasping basic statistical facts such as that a person with the typical signs of a rare condition probably does not have the condition, that exceptional cases will regress to the mean, or that relaxing the standards for reporting an uncertain event will increase both hits and false alarms.

I would like to see required courses on the major analytic tools of logic, probability, and critical thinking, particularly those that serve as prosthetics for the limitations of everyday human cognition. The pedagogical challenge is to prepare students to *apply* these tools, since other research suggests that people often don't generalize abstract rules to new domains.

In sum, general education in science should stimulate a worldview grounded in our best understanding of reality, provide a complement to knowledge in other fields, and equip students with factual analytic resources to enhance their effectiveness as individuals and citizens. The best way to attain these goals, I think, is to develop synoptic courses that are organized around content rather than discipline, and ones that explicitly target the limitations of human cognition.