The imperative for chemists to teach about sustainability

Chemistry plays a central role in many of the global and local aspects of sustainability: with problems of continued dependence on fossil fuels, and with the promise of new types of clean and renewable energy systems; with the production of toxins that pollute our water, soil, and air, and with new technologies for detecting and remediating pollutants in the environment; with wasteful and resource-depleting manufacturing, and with the design of new recyclable materials and "green chemistry" processes. A rapidly emerging green sensibility is transforming business, policy, the marketplace, and some aspects of higher education.

Our undergraduate chemistry curriculum seems to be lagging behind the constituents at either end of our bailiwick. Incoming college students are bringing to our campuses a new level of enthusiasm and passion for issues of sustainability and the environment. And paths out of college are leading into a rapidly changing career environment, in which graduate research laboratories and businesses in the chemical sector are shifting their focus toward the science and products to serve a society seeking a more sustainable path. Surprisingly, even sustainability initiatives in college operations may be ahead of curricular change.

To be sure, some chemists are employing diverse and creative approaches to teach about sustainability, at institutions ranging from vocational colleges to research universities and with students studying science, the liberal arts, and business. Some of this is happening through new instructional units and laboratory experiments on specific topics such as water pollution, synthesis of biofuels, greenhouse gas emissions, photovoltaic materials and toxicology. In other institutions, entire courses have been re-designed to emphasize sustainability or one aspect of it. The most ambitious efforts have built new academic programs and degree paths in sustainability.

But these are nascent initiatives. Even a cursory look through the leading college chemistry textbooks would suggest that the general state of chemistry education—at best—is making modest green redesigns to an established formula (adding "little boxes" to the textbooks), or—at worst—is ignoring this important change altogether.

The sometimes overused (and occasionally abused) term "sustainability" deserves a healthy dose of skepticism. *Advertising Age* listed "sustainability" as one of the "jargoniest jargon" words of 2010, and a 2009 article in *Scientific American* on the top-10 myths of sustainability noted that "even advocates for more responsible, environmentally benign ways of life harbor misunderstandings of what 'sustainability' is all about." Viewing sustainability as being about survivability offers one focus. The ubiquity and gravity of the problems facing our planet and societies—and the valuable role that chemistry can play in seeking solutions or responses to those problems—indicate that the ways chemists will be employed to serve society are changing fundamentally. To remain relevant, chemistry education must adapt.

Chemistry will be central to developing clean energy systems; to designing advanced materials for improving energy efficiency, made from renewable feedstocks, and able to be recycled; to inventing new ways of detecting and removing pollutants from water, air, and soil; to designing new approaches for sustainable agriculture and biofuels; and to creating new diagnostics and treatments for a sustainable health care system. Many of these topics already have a natural overlap with much of the undergraduate chemistry curriculum.

So while the imperative to teach about the chemistry of sustainability becomes more clear, *how* we might do this remains a challenge for college chemistry faculty. What are the critical chemistry-related sustainability topics? Which content and process skills are essential for new career paths? Must we add new content to an already-crowded curriculum? How will revising existing courses affect the integrated structure of a departmental curriculum? What resources could help support faculty interested in working on this transition? Answers to these questions will emerge from continued discussion within the chemistry community about ways to incorporate sustainability topics in our curricula, and by sharing ideas, examples, and materials with educators in other disciplines.