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From Cross-listing to Campus Collaborations

My Vexation

I teach a variety of students from introductory non-science majors to advanced physics/chemistry/geology/biology majors. Whenever I try to stretch students by exploring material outside their expectations I hear comments like: "I am not into math, I just don't think that way" or "I'm a physics major, not an English major" or "I just don't get those biology majors."

By the time my students have entered their second year as undergraduates, most have defined themselves in one camp or another. Science major, non-science major; physics major, chemistry major; biology major, geology major. Once that sets in, very few are willing to explore those other areas since they are "not a biologist" or "not a physicist."

This vexes me. I always thought the hallmark of a scientist was to be at least *interested* in nearly everything. But I think the structure of how we train scientists, from our introductory courses up through our professional organizations, forces students to consider themselves one thing or the other. Our entire system is also a bit schizophrenic on this issue. Universities support interdisciplinary study, to a point, but when it comes to budgets, departments and colleges draw the boundaries. Federal organizations supply funding for interdisciplinary research until the next budget crisis, when funding is cut in favor of more "basic" research. Here are some specific examples:

- I am a graduate of the University of Washington's Astrobiology program, though I hold a Ph.D. in Astronomy. Professors in the program either taught courses on overload or "volunteered" as few departments would reallocate teaching resources for the program's course load.
- I have taken courses in scientific writing and communication, which culminated in publication in a full-color, glossy (i.e. professional) science magazine. But the costs of producing the magazine and providing interdisciplinary faculty to teach the courses compete with departmental concerns, and so this award-winning program is losing its home, funding, and faculty.
- NASA just washed from its mission statement language that supported interdisciplinary research in climate systems, and is reducing their funding for interdisciplinary programs like the NASA Astrobiology Institute, even though these programs have been nurturing a large group of undergraduate students, graduate researchers, and postdocs that are just now beginning to search for jobs.
- I am preparing for an introductory course in astrobiology, but it is listed only as a physics course, similar to Elementary Astronomy. This is primarily because it streamlines the curriculum approval process. I can get outside experience from other departments on a "volunteer" basis.

Some interdisciplinary research programs are funded at high levels (judging by NSF support for nanotechnology, information technology, and others), and graduate programs such as the NSF-IGERT (Interdisciplinary Graduate Education and Research Traineeship) support research assistants, although the program only lasts for three to five years, making assessment difficult. However, interdisciplinary undergraduate courses are still rare, and, though topically interdisciplinary, are usually taught by one department. Most of the challenging science problems facing our nation, such as global warming, energy independence, emerging nanotechnology, medical technology, computer and interface design, etc., require students with extraordinarily diverse backgrounds. Yet I see few moves at the university level and professional level to institutionalize interdisciplinary programs, especially for undergraduates.

There are some examples. At Weber State University, we have the Bachelor's of Integrated Studies that allows students to build a program with a variety of courses from three thematic groups. We have cross-listed courses such as geomicrobiology that draw on the expertise of several faculty. There are also "Writing Across the Curriculum" courses that attempt to pair science courses and writing courses to develop skills that relate directly to a student's major. But, by and large, students are subjected to physics, biology, geology, and chemistry courses, with writing, mathematics, and computational skills added out of context.

I find this troubling since we need to train the next generation of scientists not as physicists or biologists, but as scientists. Surely they will specialize in one field or another, but they should not see the other fields as separate and disconnected from their own.

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Venture

I think there are a number of ways to make interdisciplinary studies core to the student experience, as well as some outstanding questions that need to be answered:

At the course level - All courses can include discussions of connections to other disciplines. These discussions should be integral. Additional skills required for the discipline (namely mathematics, writing, and computing) should be coordinated "in context" by programs like "Writing Across the Curriculum." *What do we leave out to make room for these components?*

At the department/college level - Cross-listed courses are an important component to all departments and colleges, and I would suggest that all students have interdisciplinary courses as a requirement. These are not courses in another field that relate to the student's major, but truly interdisciplinary experiences. Examples would include courses such as geomicrobiology or nanotechnology that are team taught by experts in each field. *How can we "institutionalize" such components cross-curriculum, and how do we allocate faculty time and department resources to cover these courses?*

At the university level - We need to develop more Centers and Programs that focus around a theme other than a single discipline. This is a break from the "Department/College" model of the University (which is still integral) to programs that offer courses and provide resources centered around areas of interest. For example, at Weber State, we are developing the Scientific Analysis and Visualization Initiative (SAVI). This collaboration between faculty from four departments and two colleges crosses all of the sciences, mathematics, and computer science using computation and visualization as the unifying theme. *How can we provide funding, work-spaces, and support for these types of programs without infringing on departmental and college resources?*

At the professional level - We need to foster interdisciplinary professional organizations (or, at least, interdisciplinary branches of existing societies). Moreover, representatives from the different professional groups must attend these conferences. For example, we recently developed a joint session in planetary science at the Geological Society of America meeting in Salt Lake City. Getting members of the American Geophysical Union to attend an American Society for Microbiology meeting, for example, might foster a number of advances in education and research. This could be promoted through cross-membership meeting discounts and other similar incentives (such as those provided by the American Astronomical Society and the American Geophysical Union, to name two). *How can we promote these partnerships and sponsor attendees that "break out" of their field to form new collaborations?*

At Weber State, we are focusing our effort on expanding the department and college level collaborations with SAVI. We recently applied for a NSF-CCLI grant which will provide funding for a new course initiative, provide research mentors and stipends for students, and bring industry partners in for an annual conference to discuss ways of improving courses and keeping students up-to-date on current trends in technology. Our goals are to find ways to expand students' experiences to include interdisciplinary work as soon as possible in their education, and relate it to the workplace. However, the challenge is still to find resources and work-spaces that everyone can use. By pooling the resources in geosciences, chemistry, physics, and computer science, we've provided students with more choices in student research, and more opportunity to work with diverse faculty. One of our geography students is working closely with geosciences and physics faculty on Mars remote sensing, preparing him for a research position at the CIA. Another student, through SAVI and the Bachelor's of Integrated Studies degree, is combining physics, graphic design, and communication to develop planetarium shows for the public. Another student is applying parallel programming to chemical models. If we are successful in growing the program, these experiences will be common rather than exceptional cases.

There are a variety of methods for enhancing interdisciplinary research and education for undergraduates. With support from the NSF and other agencies (through recommendations from interdisciplinary professional organizations) research already has a strong start. We can promote similar advances in education through our courses and by supporting collaborations between our departments and on our campuses. Considering the interdisciplinary nature of the "grand challenges" facing science in the 21st century, I would like to discuss ways of making multi-disciplinary collaborations the norm, or at least not remain so abnormal, in both research and education.