SCIENCE ACROSS THE CURRICULUM - THE BINGHAMTON UNIVERSITY STORY

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In 1996, Binghamton University inaugurated its first General Education Program for all students. The process of discussing and approving requirements for this program had an immediate and a lasting effect on how students on our campus experience learning in mathematics and science.

The most visible and immediate impact came from new graduation requirements in mathematics as well as in the sciences. All students were required to take a science course with a laboratory component, in which they would learn the methods and practices of experimental science in a discovery-based learning environment.

Extensive discussions within the faculty and administration about the educational needs of all students were the foundation for the new general education program and related graduation requirements. But, as it turned out, such dialogue around issues of student learning also opened up our community to considering more innovative approaches to strengthening student learning in science and mathematics.

When the National Science Foundation (NSF) announced, in fall 1996, a grant competition for institution-wide reform for undergraduate STEM programs, our faculty were responsive. As the University's vice-provost for undergraduate studies at that time, I knew many science faculty believed that the general education requirements just established were only a bare minimum, and that more needed to be done.

At a meeting of STEM faculty, the idea emerged that we could fortify the science/math requirements by incorporating STEM material in non-science courses. This idea took advantage of Binghamton University's designation as a State University of New York (SUNY) research university, and of our history as a high quality undergraduate institution known for its cooperative teaching ventures. The University already enjoyed functioning programs in writing across the curriculum and languages across the curriculum. We asked ourselves: "Why not one in science across the curriculum?"

This idea was translated into a proposal to NSF, resulting in a three-year grant for a program that came to be known as SxC. Sponsored by the SxC steering committee, in cross-disciplinary conversations we began to discover ways to incorporate science across the curriculum.

Binghamton University has earned a reputation for innovative academic and student life programs, outstanding students, faculty and staff, and the highest graduation rate in the SUNY system. For 50 years, we have been sustained by a vision of excellence that has earned us accolades as the "crown jewel" of New York State's public university system. From unheated Quonset huts offering returning GIs the chance to attend a public liberal arts college to the soaring glass walls of our new academic buildings, Binghamton has made that vision a reality.

- Excerpted from "Statement of the President," by Lois B. DeFleur.
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The goals of the program were to build on skills developed in General Education mathematics and science courses to:

- provide all students with basic skills and experiences necessary to appreciate science as a subject of learning for everyone, not just scientists
- allow students to discover for themselves how much the humanities and social sciences depend on advances in science and technology
- provide students with a foundation for future learning grounded in a deeper understanding of science, mathematics, engineering and technology, because all play an increasingly important role in our lives.

In retrospect, it is clear that SxC co-project initiators were wise to work within the framework of existing courses. New requirements could not be feasibly imposed, but we could and did create multiple opportunities in which students would discover that science and technology suffuse our lives and, thus that such human endeavors are embedded in virtually all the courses they learn. We set as our main outcome increased student interest in STEM, rather than a measurably increased knowledge of STEM per se.

Anna Tan-Wilson found a memorable way of articulating this goal, circulating words from Sheila Tobias that became the SxC virtual motto:

> *...make mathematics and science part of the liberal arts. ...think of it as increasing the stickiness and surface area of the students' mind itself ... with every passing year, there is more sticky stuff in place, more yearning to know, more capacity to learn!*

Building "linked" courses was the first SxC objective; with enthusiastic administrative support over 100 faculty members developed over forty SxC "links." STEM faculty were invited to visit classes in disciplines in other divisions to lend expertise and hold discussions with students outside their science classrooms. We quickly realized that such links would also be a good way to broaden perspectives of science students as well, so humanists and social scientists were invited to bring their expertise into science courses.

For example, a folklorist in the English department taught students in bioorganic chemistry studying about drug discovery about the very beginnings of that science. Sometimes these linkages took place during extracurricular activities as when a physics professor brought his clarinet and saxophone to band practice session and gave students a lesson in the physics of sound. Strikingly, many requests were for discussions on evolution, and these have crossed all disciplinary boundaries.

On a campus with about 500 faculty members who do not always know one another, the SxC leadership was able to facilitate all these exciting, innovative, and sometimes unexpected connections across the institution.

Our measure of success was if students would...voluntarily read, view, and discuss material with scientific content. To assess this, we administered a short survey at the beginning and at the end of class visits in SxC courses. The questions sought to measure self-reported interest in and frequency of students' reading, watching, or discussing "material with scientific content" ("Rarely," "Yearly," "Monthly").

On a scale of 1-5 (1=little or no increase in science interest and 5=a typically daily increase), we found a strong increase in the likelihood of students' reading news articles on the topic covered in class: 3.91 (0.37 std dev); or discussing the topic covered in class: 3.73 (0.35). We found a lesser but still significant increase in interest in discussing any science topic with someone else 3.57 (0.31). Notably, in the two courses where more than one SxC visit occurred, students registered a still higher interest in discussing the science topic treated–3.75 and 4.0.

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The qualitative data is equally, revelatory:

> *"A student in the History of the Future course stated, Great idea. More people need to know the latest trends in the world of science. A student in a class on science fiction wrote, [The] professor...offered a scientific view to the books we were reading and related them to physics. He made us aware of points in the book which we would have otherwise been unaware. And a freshman volunteered, "It's interesting to see how other disciplines are so important to science." Guest speakers help make this evident more so than any reading material."*

Even though the grant period is over, the "links," have continued informally, sometimes morphing into courses created and taught by faculty members across the invisible cultural boundary between STEM and other academic disciplines.

A key faculty member person in these continuing interactions has been David Wilson, the nationally known author of Darwin's Cathedral. Wilson was a generous SxC contributor from the very first, visiting classes from psychology and philosophy to English literature to talk about his specialty—the evolution of human behavior. He continues to assist colleagues in incorporating evolutionary thought into their teaching.

Starting in Fall 2003, SxC efforts in this realm will become more formal. Working, again, largely within the framework of existing courses but creating a few new key courses, the University will offer a certificate program on evolution across the disciplines under Wilson's leadership.

A focus on this central theme in biology is most timely since scientists are beginning to understand evolution through the study of whole genome sequences, and to put such knowledge to practical use. This certificate program is a significant evolution of the SxC program on the Binghamton University community.

The shared SxC experiences fostered lasting bonds of cooperation, and thus have influenced other aspects of campus life, most visibly through the new Center for Learning and Teaching. We have created an annual CLT-sponsored Faculty Institute for Student-Centered Learning. A recurring feature of the Institute is that noted science faculty members-- all SxC leaders-- introduce colleagues across the institution student-centered ways of teaching scientific concepts and materials. This is one key way that, despite a challengingly fiscal climate, we continue to try to break down disciplinary boundaries to improve the way we teach our classes and facilitate the learning of our talented students at Binghamton University.

Binghamton University has always recognized its responsibility for service to the broader community, and thus central to the SxC initiative was a major public SxC colloquium that brought noted speakers to campus twice a semester. Our auditorium fills to capacity with both community members and students, sending a message to our students that knowing about science will continue to be important throughout their lives when they leave our campus and become responsible citizens.

As I look back, there were several underlying conditions and two major catalysts that contributed to the building of communities committed to science across the curriculum on our campus.

The first catalyst was that in the early 90's years the science programs at Binghamton University had achieved substantial success in receiving grants from the NSF, the Hughes Foundations, and several others, along with several close misses. The collaborations necessary for these grant submissions went far toward creating a community dedicated to institutional reforms, a community with a purpose and vision.

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The second catalyst was the advent of General Education itself. Binghamton University's General Education program fostered new, cooperative ways of thinking as science departments focused on the contributions their various disciplines could make to the education of our non-science majors, when each entering class numbered almost 2000 students. As vice-provost for undergraduate education, I wanted and needed to facilitate these cross-disciplinary connections and even to create new one.

For example, the new science requirement not only demanded a universal hands-on laboratory course for our students, but also a rationale. Revealingly, when leaders from the various disciplines came to write that rationale, they quickly realized that the very notion of "the scientific method" was a reductive one, since each of the sciences had its own truth-finding procedures.

One important result of this experience was that our science departments felt a need to expose more of our students to the wide range of scientific endeavor, not just one course. This desire created the fertile ground for the luncheon meetings my office convened that led to our NSF proposal for Science Across the Curriculum, a program that proved ultimately to stimulate cross-disciplinary connections and to enhance the teaching commitments of the science departments and the entire University.

The conclusion I draw from these experiences is that faculty creativity accompanied by administrative facilitation is a powerful combination. This is how bonds of trust are forged. Moreover, when outside agencies such as NSF offer financial incentives that support existing priorities, powerful results are likely to follow. While we are some years past active grant funding, because of our common purpose we have found ways to sustain innovation that has benefited our students. ■