Science education at liberal arts colleges: why they do it so well

BY THOMAS A. STEITZ

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I am here to convince you of what many of you already know, namely that small colleges are disproportionately successful in training their students to be scientific leaders. In doing so, I would like to expand upon some points made by Tom Cech in an article on science training by small colleges that appeared in the Winter 1999 issue of *Daedalus.*

My personal experience with graduates in science from small colleges is that they are often not only highly successful but frequently have significantly broader perspectives than their colleagues who received their training at large institutions. Four of the 11 tenured faculty members of my department at Yale obtained their bachelor's degrees from small colleges. In addition to Lawrence University, they include Antioch, Reed, and Pomona Colleges. Three of these four faculty members are members of the National Academy of Sciences, and the fourth just won a prize as the most outstanding scientist under the age of 35 in all fields.

Accepting that small colleges are more successful at training scientists, what is it about the education at liberal arts colleges that accounts for this success?

Small classes. Although the names of courses and their contents are similar, differences occur in the manner in which they are taught. At colleges, lecture sessions rarely exceed 50 students in an introductory class and drop to perhaps a dozen in the upper-level science courses. The largest lecture room in Lawrence University's new Science Hall seats fewer than 85 students. At research universities, that number is typically much higher, often many hundreds (the largest at Yale seats 300). In such large classes, students often are the passive recipients of information. Small classes provide the opportunity for students to engage actively in the learning process and acquire a sense of self-esteem and confidence.

Faculty who are motivated teachers. Many professors at large universities enjoy teaching — or at least take some satisfaction in their teaching — but it is rarely their first love. They were trained primarily as researchers, and their promotion and tenure decisions are almost totally dependent on the papers they publish and the invited research talks they present. In contrast, liberal arts college faculty are committed to teaching by career choice. Their reputations are heavily tied to teaching, and teaching that is simultaneously rigorous, innovative, and popular is especially prized. They are also committed to research—which at top colleges constitutes only one major criterion for promotion — but the expectations are appropriate.

Cross-training in the humanities and arts. Athletes often improve their competitive edge by incorporating a variety of exercises or other sports not directly related to their major sport. Analogously, a liberal arts education encourages scientists to improve their

competitive edge through cross-training in the humanities and the arts that develops a student's ability to collect and organize facts and opinions, analyze them, weigh their values, and articulate an argument. With literature, history, and the arts, one learns to distill the critical elements from the irrelevant, synthesize seemingly discordant observations, and develop a strong argument. Scientists need the same skills as humanists to cut through misleading observations and arrive at an interpretation.

Another obvious value of humanities classes for a scientist is the development of communication skills. Success in science is dependent on an ability to write well-organized and clear manuscripts and grant applications and on oral communication skills and an ability to present one's research in a manner both convincing and exciting and perhaps even entertaining.

In-depth study in one field can provide perspective and vision in another. One consequence of my Lawrence education that was missing from many of my graduate school classmates at Harvard was my sense of the big picture and what issues were of central importance. This I attribute to Freshman Studies at Lawrence and courses in philosophy and anthropology, courses that ask many of the big questions in life, though these fields are not always so effective in answering them. Just as science students benefit in many ways, not just professionally, from studying humanities and the arts, so should a humanities or arts student benefit from the window into the world provided by science.

How wonderful it would be if all graduates could read and appreciate *Scientific American* or the Tuesday "Sciences Times" part of *The New York Times.* Increasingly, managers of every type of business encounter technical issues in the daily decisions they must make, and government on all levels requires scientific and technical insights. Shouldn't the nation's leaders know something about the science that underpins the decisions that shape our future?

The challenge that faces the science faculty is to teach a course that is engaging and relevant to the non-scientist, rather than narrow and technical. What better place is there to do this than at a small liberal arts college like Lawrence? It is essential to address the students in the class at their level — rather than the level you wish they were at — and get them excited about science.

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Why is it important for a liberal arts college such as Lawrence University to have new laboratory facilities, when it is primarily a teaching rather than a research institution? Adequate-but-marginal facilities might have sufficed in the past, but much has changed in science and science education since I was an undergraduate. Experiments in all branches of science, particularly the biological and chemical sciences, are now far more dependent on sophisticated instruments that are expensive and take up space.

When I was a student, there were almost no independent faculty research projects at Lawrence that provided opportunities for students to pursue independent research. Now it is possible for students to obtain excellent research training doing independent projects under the supervision of the same faculty members who are instructing them in courses. Inquiry-based laboratory research projects are extremely important in training students to understand the relationship between experiments done and conclusions reached. It is vitally important for them to understand that science is a process, not a list of facts to be memorized for the next exam. Science is about problem-solving, asking questions and seeking answers. Science is a process that students can find useful in endeavors far outside the experimental research laboratory.

Buildings shape our interactions and our lives, and new science facilities at Lawrence and other small colleges will help shape science education for many, many decades into the future, doubtless the entire 21st century. Many future generations of students will benefit from the new possibilities they enable.

Important as buildings surely are, however, it is the faculty members who teach, motivate, and inspire the students. Lawrence University and other liberal arts colleges of a similar character have been blessed with wonderful faculty in the past. The investments in new science facilities that are happening across the country will greatly help these colleges to continue to attract the best teaching faculty to their ranks and help them realize their goals of doing their teaching job well. ◆