Growing Math Majors at St. Olaf College

Lynn Arthur Steen

The mystery of mathematics is how it can be so shunned at the moment of its greatest triumphs. Behind the decoding of the human genome one finds algorithms of patterns and combinations; behind the animation of Oscar-winning films one finds algorithms of geometry and projections; behind the new on-line financial markets one finds algorithms of data mining and secure communication. No longer confined to physics and engineering, mathematics is the foundation for what is often called the "new economy."

Yet for years headlines have proclaimed depressing news about the poor standing of U.S. students in national and international assessments. Academics worry about a parallel trend: the percentage of U.S. college graduates who major in mathematics has declined steadily for three decades, and is now only one-third of what it was in 1970. Only one in a hundred college graduates now majors in what used to be called the queen of the sciences, and only one in 25 of those majors goes on to a Ph.D. in the mathematical sciences.[1] And this at a time when advanced mathematical tools are being employed more widely than ever before, and when mathematicians command six figure salaries in enterprises ranging from Wall Street to Hollywood.

In this context it is not surprising that people are intrigued by the mathematics program at St. Olaf College which, for all but two of the last twenty years, has produced mathematics majors at more than eight times the national average. These majors are no slouches: they have gone on to earn Ph.D degrees in the mathematical sciences at a rate 50% higher than the national average. As a consequence, when the National Science Foundation reported on the undergraduate origins of mathematics Ph.D. degrees earned between 1990 and 1995,[2] St. Olaf ranked sixth in the nation, behind only UC-Berkeley, Harvard, MIT, Chicago, and Cal Tech.

It is natural to wonder how this came to be and whether the St. Olaf "secret," if there is one, might be adopted by other colleges. St. Olaf is a liberal arts college of 3000 students, half from Minnesota. These students are pretty much like students in other moderately selective liberal arts colleges with SAT scores mostly between 1100 and 1300. Our faculty work about as hard as their peers in other colleges, although based on national norms they are all underpaid. As an institution, St. Olaf ranks just below 50th in the US News college rankings of national liberal arts colleges, and is better known for music than for mathematics in its mostly upper midwest constituency. To produce that many mathematics majors, we mostly have to grow our own.

In the early 1970s, as mathematics departments everywhere struggled to adapt a curriculum that had become too rigid for changing student interests, St. Olaf mathematicians decided to let students help shape their own major by "contracting" with their departmental advisors for a selection of advanced courses that both met their career interests and contained an appropriate breadth of mathematics. In effect, the faculty joined their students as partners in the struggle to modernize the curriculum as mathematics moved hesitatingly into the computer age. In 1981 a committee of the Mathematical Association of America (MAA) cited St. Olaf's "contract major" as a major source of its success.[3]

Fifteen years later, following a decade in which the percentage of St. Olaf mathematics majors remained consistently in double-digits, another visiting team from the MAA identified a variety of additional features that helped explain the department's success.[4] Chief among these is its continuous emphasis on students as the focus of the department, from a long-standing placement program that typically achieves a 90% success rate in calculus[5], to numerous extra-curricular activities (a student MAA chapter, weekly newsletter and colloquium, problem-solving groups) and social events (ice cream socials, annual pig roast, and a math department music recital). These show students "that mathematics is not an elite discipline for the few, but a lively and accessible subject appropriate for all."

As the MAA reviewers noted, these student-oriented activities sustain but do not alone create the environment that attracts well over 100 upper class mathematics majors. The environment, they suggest, depends

on a faculty that is never static, that is never satisfied with the status quo, that is always looking for ways to improve and for grants to support these ideas. The innovative contract major was one such effort; others include:

- undergraduate research opportunities for advanced mathematics students dating back more than thirty years;
- early and extensive integration of statistics, computing, and computer science;
- a January-term "practicum" for team work on industrial or government problems (e.g., streamlining Northwest Airlines security lines);
- leadership in national problem-solving competitions;
- active participation in professional societies—which has led several faculty to editorship and officer positions;
- a Visiting Master Teacher program for outstanding high school teachers;
- several external grants for curriculum and computer laboratory development;
- a grant-supported program of "teaching post-docs" for new Ph.D.s to gain experience in liberal arts college teaching;
- special mathematics programs in Budapest and (recently) at the Biosphere in Arizona.

These faculty-instigated programs help show students that mathematics is an active field—not something that exists only in textbooks and exams. The enthusiasm of faculty for their work rubs off on students who see the department as a fun place to hang out and mathematics as a subject with varied and interesting opportunities for careers. Quite a few go into high school teaching, and some of their students subsequently attend St. Olaf primed with stories about what it is like be a St. Olaf math major.

Each layer of explanation, like a Russian doll, reveals yet another question: What sustains and energizes the faculty? The answer, in part, is a written departmental consensus, regular revised, on broad standards for the integration of faculty teaching and professional activity. This statement, similar in spirit to the "reconsidered" scholarship advocated by Ernest Boyer,[6] is anchored in a belief that mathematics is an active, hands-on, "big tent" subject, a true liberal art offering intellectual habits of mind that are as useful in the film studio as in the genomics lab.

Faculty professional work is as varied as student interests, and as often as not is done with some degree of collaboration. In the end, the true energizer of faculty is interactions with students.

Lynn Arthur Steen is Professor of Mathematics at St. Olaf College.

[1]Snyder, Thomas D. and Charlene M. Hoffman, eds. *Digest of Education Statistics, 1999*. Washington, DC: National Center for Education Statistics, 2000.

[2]Division of Science Resources Studies. Undergraduate Origins of Recent (1991-95)Science and Engineering Doctorate Recipients. Arlington, VA: National Science Foundation, 1996.

[3]Committee on the Undergraduate Program in Mathematics. Recommendations for a General Mathematical Sciences Program. Washington, DC: Mathematical Association of America, 1981, p. 22.

[4]Tucker, Alan C., ed. Models that Work: Case Studies in Effective Undergraduate Mathematics Programs. Washington, DC: Mathematical Association of America, 1995, p. 47-51.

[5]Cederberg, Judith N. "Administering a Placement Test: St. Olaf College." In Bonnie Gold, Sandra Z. Keith, and William A. Marion (editors). *Assessment Practices in Undergraduate Mathematics* . Washington, DC: Mathematical Association of America, 1999, p. 178-180. URL: http://www.maa.org/SAUM/maanotes49/178.html

[6]Boyer, Ernest L. *Scholarship Reconsidered: Priorities of the Professoriate*. Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching, 1990.