

## Leadership in Undergraduate Mathematics Education: An Example

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Lynn Arthur Steen, Professor Emeritus of Mathematics at St. Olaf College and former President of the Mathematical Association of America, is recognized widely for the extraordinarily valuable leadership he has given in undergraduate mathematics education, at his college, nationally, and internationally. This article outlines some of his remarkable contributions, shares some of his thinking about his experience, and includes a few further reflections.

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When Christopher Huson, this issue’s editor, invited me to submit an article on leadership in undergraduate mathematics education, he hustled me a bit by praising the spring 2011 Teachers College seminar on mathematics in American colleges, in which he was one of the participants. His kind comments brought back happy memories of the bi-weekly conversations that Professors Neil R. Grabois and J. Philip Smith and I had with that group, and they led me to agree to try, as Editor Huson put it, to capture “some of the thoughtful commentary” from those sessions, which arose from Professor Bruce R. Vogeli’s enthusiasm with having three former college presidents in the Teachers College Mathematics Program that year.

I loved the opportunities that seminar provided for exploration and reflection with gifted students and colleagues. However, when I began to stir its embers, a compelling flame did not instantly appear, and a few days later, when I was losing the thread of a research talk at the January 2013 Joint Mathematics Meetings in San Diego, I turned to worrying about the promised article and thought of asking others there for their help with it. Several were generous in talking with me, including past Mathematical Association of America (MAA) Presidents David Bressoud, Thomas Banchoff, and Lynn Steen. Others with whom I spoke included Nancy Baxter Hastings and Kyle Riley, who were concluding their service as Co-Chairs of the MAA Committee on Departmental Review, William Dunham and Penny Dunham of Muhlenberg College, David Stone of Georgia Southern University, and Jon Johnson of Elmhurst College. Later I talked with another former MAA President, longtime friend and mentor Lida Barrett. Many of these people responded to my request for examples of successful leadership in undergraduate mathematics by citing others in this group. I am especially grateful to Tom Banchoff for his insights on leadership in the Brown University Mathematics Department over his more than forty-five years as one of

its members, but because much of that history deals with graduate and research programs, I will hope to come back to it in a different setting. For this one, it was helpful that in my thoroughly unscientific poll, Professor Steen was cited by nearly everyone with whom I spoke. As David Bressoud put it, “No one has led more effectively than Lynn Steen in the development of undergraduate mathematics during our lifetime.” And it was a great gift when Dr. Steen agreed to discuss his experience. He was generous in talking with me during the meeting and in exchanging e-mail messages over the next several weeks. Our pattern was for me to raise a few questions and for him to respond with thoughtful reflections. Again and again, he credited others with having drawn him into new opportunities. When I asked about his leadership, he backed away from that word, saying that the accomplishments for which he has been recognized depended heavily on good fortune and the contributions of others. I am pleased to be able to share some aspects of the example he has set and to pass on at least a bit of his wisdom and grace.

Lynn Arthur Steen grew up on Staten Island. His father was Wagner College’s choral conductor and his mother sang with the New York City Center Opera. He completed his bachelor’s degree—with majors in mathematics and physics and a minor in philosophy—at Luther College in 1961 and his Ph.D. in harmonic analysis at the Massachusetts Institute of Technology in 1965 under the direction of Kenneth Hoffman (who later himself gave national leadership for the mathematical community as the first director of its Washington Office of Governmental and Public Affairs).

Steen joined the faculty of St. Olaf College in 1965, at age 24, attracted in part by the opportunities that would come quickly there with the retirement of most of the Mathematics Department’s faculty members and the College’s plans to double in size over the next fifteen years. Working with J. Arthur Seebach, Jr., the other new faculty member who arrived at the same time, Dr. Steen led in

renewing the Department's curriculum to be more accessible, to accommodate the growing numbers of St. Olaf students participating in study-abroad programs, and to respond to the curricular recommendations in the groundbreaking 1965 report of the MAA's Committee on the Undergraduate Program in Mathematics (CUPM) (Duren, 1965). Steen and Seebach also broke new ground by engaging undergraduates in research. With National Science Foundation (NSF) support, they achieved excellent results that included the publication in 1970 of their *Counterexamples in Topology*, (Steen & Seebach, 1970) to which several of their undergraduate researchers contributed.

In the years that followed, St. Olaf's Mathematics Department grew and prospered. A 1981 CUPM report (CUPM, 1981) applauded its success in attracting and serving large numbers of majors and sending large numbers of them on to doctorates in distinguished graduate programs; it noted that the Department's individual crafting of degree requirements through contracts developed together by advisers and students as a major factor in this success. And the Department has continued to be recognized nationally for its achievements, for example in a 1995 MAA collection of case studies of effective undergraduate mathematics programs edited by Alan Tucker (1995).

From his arrival at St. Olaf College through his retirement from its faculty in 2009, Lynn Steen has given extraordinary leadership and service to the St. Olaf Mathematics Department, the College as a whole, and the mathematics community nationally and internationally. His curriculum vitae (Steen, 2013) comprises twenty tightly-packed pages, with nearly 750 entries reflecting his standing as a highly effective writer and much appreciated leader of complex projects.

Lynn and Mary Steen had been married two years when they got to St. Olaf. They met as students at Luther College where they were co-editors of the student newspaper in 1960–61, when Lynn was a senior and Mary a junior. After Luther, Mary worked as a grader for the Harvard Business School's Written Analysis of Cases course and completed a Harvard Master of Arts in Teaching degree in English before the move to St. Olaf, where she took a job teaching writing at the same time Lynn joined the mathematics department. The Steens retired together in 2009, she as Associate Professor of English, having taught a variety of courses including Science Writing courses with Lynn and courses she developed on the literature of Australia and New Zealand. They have two daughters and six grandsons.

When I asked Mary for her insight on what has made possible Lynn's impressive accomplishments, she was quick to say: "Lynn doesn't like to do the same thing twice. He relishes new challenges." She noted that she sometimes likes to walk in the same woods more than once; Lynn, not so much. And she added: "He's persistent."

One of many instances of Dr. Steen's finding his way into new woods occurred in 1970–71, when he received a NSF Graduate Fellowship for a sabbatical leave in a special-year program on harmonic analysis at the Institut Mittag-Leffler in Sweden. While there, he discovered the Institut's spectacular collection of historic mathematics and science correspondence, manuscripts, and books, and he renewed the appreciation he had acquired in graduate school for the approaches of many Russian and Hungarian authors to mathematical exposition. With that inspiration, he undertook to write an article on non-standard analysis, a topic that had interested him since graduate school and allowed him to try his hand at writing for a broader audience than the mathematicians and mathematics educators for whom his 1970 *American Mathematical Monthly* article with Arthur Seebach and Linda Seebach, "What is Sheaf," (Seebach, Seebach, & Steen, 1970) was aimed. Steen recalls that, on a whim, he submitted the non-standard-analysis article to *Scientific American* where it was published in 1971 (Steen, 1971). Another factor Steen recalls in his decision to try writing for this broader audience was the observation in the National Academy of Sciences' 1968 reports of its Committee on Support of Research in the Mathematical Sciences (COSRIMS, 1968a, 1968b.) (which, along with the 1965 CUPM report played a role in the vigorous debates about St. Olaf's mathematics curriculum) that not even scientists know how rapidly the mathematical sciences are expanding.

Another new woods into which Steen was drawn in 1970, along with his colleague, J. Arthur Seebach, Jr., was coordinating the heavy work of the *American Mathematical Monthly's* Telegraphic Reviews. These short overviews of new publications had been created by mathematical historian Kenneth O. May when he moved from Carleton College (the other college in Northfield, MN) to the University of Toronto in 1965. By 1970, May had made considerable progress on his goal of clearing out a large backlog of *Monthly* reviews, but the work involved had exhausted him, and he needed to find a replacement. Here's Steen's account of how the new woods found him:

[Professor May] knew that between Carleton and St. Olaf, Northfield had 15+ mathematicians who knew different parts of mathematics and had more flexible professional publication expectations than do mathematicians in research universities. So he suggested Northfield as a solution to *Monthly* editor Harley Flanders, who had been corresponding with Arthur Seebach & me about an article ("What is a Sheaf?") we had submitted to the *Monthly* based on a St. Olaf-Carleton faculty mathematics seminar. So Harley called and asked if we would be willing to set up a Telegraphic Review (TR) team in Northfield to take over the Reviews section of the *Monthly*.

That step drew Arthur and me into the committee orbit of the MAA which led, five years later, to our being named co-editors of *Mathematics Magazine*. I continued coordinating the TR section for nearly two decades (until computers made it obsolete). (personal communication, February 2013)

During the 1970s, Steen's talents came to be even more in demand. In the summer of 1973, he participated in a six-week MAA-NSF institute at Williams College on applications of mathematics in the social and behavioral sciences. In 1974 his continuing success in expository writing led to his being recruited to work half-time for a year on a Joint Projects Board for Mathematics (JPBM) grant-supported effort to encourage more coverage of mathematics in popular and scientific media and science museums. This, in turn, led to his writing more articles, suggesting topics to others, and getting to know museum directors and editors of leading national publications, including *Science*, *Science News*, and the *New York Times*.

Steen became a full professor at St. Olaf in 1975, and in the next five years, he was prolific, and nearly alone, in publishing articles about mathematics for a broad public audience and for the scientific community. He was asked to write annual mathematics articles for the yearbook of the *Encyclopedia Britannica* and to recruit mathematicians to speak at the annual meeting of the American Association for the Advancement of Science (AAAS). He and Arthur Seebach worked to broaden the appeal of *Mathematics Magazine* during their term as its co-editors and were then asked to chair the editorial committee for a new MAA publication, the newsletter *FOCUS*, where they worked closely with its first editor, Marcia Sward.

By 1980, at age 39, fifteen years after completing his doctorate, Steen was deeply engaged in the national aspects of mathematics. He was an MAA vice president, chair of the Consortium for Mathematics and Its Applications, and a member of several related committees and boards, which brought him into contact with the leaders of other national organizations including the National Council of Teachers of Mathematics (NCTM), the American Mathematical Association of Two-Year Colleges (AMATYC), the Society of Industrial and Applied Mathematics (SIAM), and the Conference Board for the Mathematical Sciences (CBMS). He has noted that "virtually all of my subsequent professional work grew out of this opportunity." (personal communication, February 2013)

Professor Steen was MAA President in 1985 and 1986. He was Secretary of the AAAS Mathematics Section from 1982 to 1988, Chair of the Council of Scientific Society Presidents (CSSP) for 1989, and CBMS Chair from 1988 to 1990. He joined with NCTM in responding to President Reagan's education commission's sharply critical 1983 report, "A

Nation at Risk," by urging that K–12 teachers should develop standards for curriculum, instruction, and assessment. This proved to be the start of the roiling movement toward educational standards through the last thirty years. Working again with his MIT dissertation advisor, Kenneth Hoffman, Steen was instrumental in the formation of the Mathematical Sciences Education Board (MSEB) at the National Research Council (NRC) to connect the K–12 standards movement with the NRC's university-based concerns.

In 1985, Marcia Sward, with whom Steen had worked closely on *FOCUS*, became the first Executive Director of MSEB, and Kenneth Hoffman took an NRC position overseeing mathematics and science education. This led to Sward, Hoffman, and Shirley Hill, the former NCTM President who became MSEB chair, choosing Steen to write the first major NRC report on mathematics education, which, after three years of his attending a great many meetings and another half year of writing, resulted in the publication in 1989 of *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* (1989). As is often the case with such works, the report was cast as a product of its three sponsoring bodies, but in their joint preface, the three organizations' chairs—Shirley Hill, Phillip Griffiths, and J. Fred Bucy—wrote: "We take this opportunity to express our gratitude to Lynn Steen for applying his considerable writing talents to the task of creating *Everybody Counts*. He has described in elegant language the complex issues of mathematical education with which we shall be grappling for years to come."

Throughout these years, Professor Steen was an active member of the Mathematics Department of St. Olaf College. He contributed to the development and regular revision of the Department's statement of goals and expectations that affirmed a diversity of contributions from faculty members. He encouraged and supported changes in curriculum and activities that made the department more broadly welcoming and supportive of students having a wide variety of backgrounds and interests. He helped to recruit and sustain able faculty members, including ones who added emphases in computer science and statistics. He taught a wide array of courses, including calculus, topology, real and complex analysis, probability, mathematical statistics, catastrophe theory, Lie groups and quantum mechanics, mathematical excursions of Lewis Carroll, mathematical applications in the behavioral sciences, and algorithms, automata, and computing. Even as the demands grew for him to participate and present in national and international meetings, Steen viewed his St. Olaf responsibilities as central. When he was MAA President and Chair of the Council of Society Presidents, he often had to commute from Northfield to Washington two or three weekends a month, which was difficult in spite of St. Olaf's accommodations in his class schedule. One year, he and a colleague team-taught an experimental two-semester-in-one

calculus course. The colleague explained the arrangement to the students by observing that he was the home team and Steen was the away team.

Professor Steen was on leave from St. Olaf for the academic years 1992–95 to serve full-time in Washington as Executive Director of MSEB, succeeding Marcia Sward, who had returned to MAA as its Executive Director. However, unlike many others who were drawn to DC, he never succumbed to Potomac Fever. He recalls:

Gradually, the frustrations of repeating the same cycle of discussions and policy proposals with little evidence of actual accomplishment limited my enthusiasm for yet one more version of standards. My frustration echoed discussions I had many years earlier at St. Olaf when departments were asked to draw up statements of professional expectations by which faculty would be judged for retention and promotion. I argued then—with considerable support in our growing department—that one will get the best work out of someone by letting them focus on what they are best at, provided only that it is subject to effective public, external critique and review. (This contrasted, for instance, with historians who demanded one book for tenure, two for full professor, etc.) I came to see the standards movement, especially as implemented by politicians and administrators, as too much like the historians' creed which suggests there is only one best route to success. It constrains creativity and risks driving away some of the best teachers (and students). (personal communication, February 2013)

The standards movement was already in full swing in those years, and concerns about excessive Federal intrusion led the National Governors Association in 1996 to form a new organization, Achieve, Inc., to develop standards for participating states. Steen was enlisted on committees convened by Achieve, and from 1999 to 2005, while also serving St. Olaf and the mathematical community in many other ways, he was intensely engaged in drafting and editing the groups' mathematics documents, with the goal of overcoming objections from some mathematicians concerning rigor.

Professor Steen completed one more major national assignment after serving as Executive Director of MSEB, in a project initiated by the College Board to find ways to raise the level of quantitative literacy (QL) in the United States. It led to his writing, and this time being fully credited with having written, *Achieving Quantitative Literacy: An Urgent Challenge for Higher Education* (Steen, 2004), which continues to be a key source in work to improve America's quantitative literacy (*cf.* Nathan D. Grawe's article in the

spring 2012 issue of *Liberal Education*). Here is some of Steen's thinking about the QL effort:

This was a bit like tilting at windmills, since QL is an enormous, amorphous issue with no natural constituency or traditional curriculum. All the work on this project was, if you will, “anti-standards.” We organized conferences and reports in which different people expressed wildly different ideas about what is needed and how it should be accomplished. Although the largest number of teachers of QL is in departments of mathematics, many of the most passionate QL advocates argue that mathematics is the worst home for QL (because of both student and faculty attitudes). Some insist that QL is a school subject and should no more be taught in college than, say, typing. Others argue that QL demands college-level sophistication, so earlier efforts are bound to fail. Etc., etc.

One thing we avoided was any effort to set “standards” for QL. Instead, we focused on providing motivation, examples, and strategies—presuming that different teachers at different educational levels and in different disciplines would develop and adapt whatever made sense to them in their local contexts. (personal communication, February 2013)

#### Reflections on Leadership

In our conversations, both in person and by e-mail, I asked Professor Steen to consider what his experience, both at St. Olaf College and nationally, might suggest about leadership in undergraduate mathematics education. Just after the comments above on the QL project, he added:

Looking back, these reflections suggest, perhaps, a leadership style that may address your question: Communicate effectively to make people aware of issues and opportunities; provide resources and ideas for approaches to solving problems; then get out of the way and applaud everyone who is working hard in their own environment. (personal communication, February 2013)

One sees evidence of these principles again and again in Steen's work and in his summary of factors that made possible the outstanding achievements of St. Olaf's Mathematics Department in the years since he joined it, factors such as welcoming students with a wide variety of mathematical backgrounds; working to develop clear statements of departmental goals and expectations; encouraging colleagues to focus on what they do best; experimenting with new approaches to curriculum; keeping lines of communication

open among faculty and students through many means including regular departmental events and a weekly newsletter; and having fun together in social activities, practice for student competitions, and playing games. (For a fuller account, see Professor Steen's 2002 article "Growing Math Majors at St. Olaf College" in the Education Trust's *Thinking K-16*).

Some other characteristics that I judge have enabled Lynn Steen's remarkable leadership:

- His writing is clear, graceful, engaging, and wise. He credits the liberal education he received at Luther College, and especially his late-blooming work in philosophy there, as having prepared him for writing the statements that played a role in his selection for Danforth and Woodrow Wilson Fellowships, which, in turn, brought him additional opportunities to think and write broadly.
- Others enjoy working with him. He is gracious, friendly, diligent, and dependable. It has happened often that someone with whom he worked on one project sought him out for a role in a later one.
- He seeks, and finds, new ways of understanding evidence. He sees patterns and draws conclusions that others miss. For example, having served as an outside evaluator for many mathematics departments, he has noted that external reviewers are often left to wonder what may have come of their brief participation in the lives of departments and institutions, and he observed that a visit that he found to be most rewarding had an unusual design: the other two reviewers were an alumnus physician and a trustee lawyer, which yielded new insights for all involved.
- He welcomes new challenges—as his wife Mary noted in the characterization mentioned earlier, he prefers not to walk in the same woods twice. And yet, unlike many of us, he started his career and stayed the course through it as a faculty member at the one institution. His loyalty through the years to St. Olaf College and its mathematics department won out over the attractions of a variety of other opportunities. When I asked how he decided when to stay with an assignment and when to leave it, he said, "If my term ended (as editor, treasurer, president, etc.), I left. If I liked my work and felt it was helping others (writing about calculus reform, or school standards, or quantitative literacy), I stayed. When I did leave a position, I never looked back or tried to keep tabs on whoever took over the job. My focus was always on some new project, never on how the old ones were getting along." (personal communication, February 2013)

- He is generous in giving credit to others—credit to colleagues at St. Olaf, credit to those with whom he worked in his many national projects, and credit to those who invited and encouraged him in finding the many new woods that drew him over the years. Steen describes his remarkable path as having surprised him many times over. He sees it as having been found largely by happy accident, or providence perhaps, rather than as a result of farsighted planning.

I hope this account of some of Lynn Steen's leadership in undergraduate mathematics will be helpful to others who are called upon to make a difference in this field. Considering his achievements can be daunting; he has done so much and done it so well that it is hard to avoid a sense of inadequacy by comparison. And there are many sources for insight about leadership in this field, including the American Mathematical Society publication edited by John Ewing, *Towards Excellence: Leading a Mathematics Department in the 21st Century* (1999), or participation in departmental reviews (for which the Mathematical Association of America's guidelines, 2010, can be helpful). Nonetheless, I believe that, whatever the opportunities and capacities one may have for leadership in undergraduate mathematics education, keeping in mind Professor Steen's extraordinary example is likely to prove valuable. I am deeply grateful to him for his generous gifts of time, thought, and inspiration.

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