A Humanistic Academic Environment for Learning
Undergraduate Mathematics

by

Clarence F. Stephens,
Professor Emeritus,
State University of New York
College at Potsdam,
Potsdam, New York 13676

A Humanistic Academic Environment for Learning Undergraduate Mathematics

Teachers of undergraduate mathematics work under conflicting professional responsibilities. In strong Ph.D. granting mathematics departments undergraduate enrollment in mathematics forms the major support for graduate students as well as the regular mathematics faculty. At these universities much undergraduate mathematics is taught by graduate assistants who have their primary obligation to their graduate studies and research. Most regular mathematics faculty at these universities have no interest in teaching undergraduate mathematics. (It is rare for undergraduates to understand or to participate in the research of their mathematics teachers.). If regular mathematics faculty teach undergraduate mathematics, the lecture method is used most often with very large classes so that the lecturers have almost no knowledge of the hopes, anxiety, or growth in mathematical maturity of their students. Mathematics faculty at these universities expect a large number of their best graduate students to be foreign students and very few will be selected from the undergraduates they teach at their own university. Research grants and fellowships are sought in order to relieve a faculty member from teaching, and in particular undergraduate teaching.

In group M and B Departments (Departments granting a Master's or Bachelor's degree as the highest degree) the teaching loads, support for graduate students and research imply that the primary responsibility for the mathematics faculty is to teach undergraduate mathematics. However, research publications compose an important part of the qualifications for tenure and promotion, although the academic climate for high quality research is not very favorable at these colleges and universities.

One estimate is that more than 50% of the current enrollment in mathematics courses at public four-year colleges is for remedial courses and pre-calculus courses. Also on average fewer than 10% of undergraduate credits in the mathematical sciences are in post-calculus level courses. Often students are assigned to remedial and pre-calculus courses by placement examinations which may not correlate very well with the preparation and ability of students to learn college mathematics, but may correlate with the academic environment for learning undergraduate mathematics at a particular college or university. In general, students do not enjoy studying these courses and teachers do not enjoy teaching them. Frequently, part-time teachers are employed to teach these courses. Perhaps the failure rate in regular calculus courses is an indication of an unfavorable academic environment for learning undergraduate mathematics, as well as the lack of effectiveness in teaching remedial and pre-calculus courses in such an environment.

In large group M and B Departments with few mathematics majors many regular faculty members may have an opportunity very rarely to teach a post-calculus course for mathematics majors. Some faculty members believe that only those students who have the ability to continue their studies in mathematics to the graduate level and to become research mathematicians should be encouraged to major in mathematics. Since research in mathematics is very competitive, mathematics majors should be limited to an elite class of geniuses, and a particular college or university may have very few or no members of this class. Thus many mathematics faculty members are encouraged to process students through undergraduate mathematics courses for supply departments and/or general college mathematics course requirements, and this processing helps to establish an unfavorable academic environment for learning undergraduate mathematics.

At two-year technical colleges and community colleges most of current enrollment in mathematics courses is for remedial courses and pre-calculus courses. Very limited or no opportunity is provided for many faculty members at these colleges to teach across the mathematics curriculum and rarely is there provided a humanistic academic environment for learning undergraduate mathematics.

Some talented and dedicated teachers at each type of school described above are able to obtain some good results in teaching students undergraduate mathematics. However, the writer contends that most students study undergraduate mathematics in academic environments which are dehumanizing for both students and teachers. Too many future elementary and secondary school teachers study mathematics in such environments. It is important for mathematicians and mathematics educators to discuss such things as the content of the calculus course and how calculus is taught, concrete vs. abstract in mathematics education, as well as the role of problem-solving. The writer challenges chairs of Mathematics Departments and other responsible academic administrative officers to provide a humanistic academic environment for learning undergraduate mathematics. If this can be done, the lay public may view mathematics more favorably, and give mathematics education and research in mathematics more support.

During the past 20 years, the Mathematics faculty at SUNY Potsdam has made a determined effort to establish a humanistic academic environment for learning undergraduate mathematics, and some unfavorable national trends in mathematics education have been reversed. Our average number of bachelor's in mathematics during the last three years is 193 and the average percent is 24% while the national average is about 1%. The gender imbalance in mathematics seen nationally is not a factor at Potsdam College. A little more than 54% of our college graduates during the last 18 years have been women and little more than 55% of our Bachelor's in mathematics have been women during the same period. At SUNY Potsdam the completion of mathematics as a major is gender independent.

Most students enroll in mathematics courses on a voluntary basis and not as a requirement for a major or minor in some other subject. Our college has no mathematics requirement as a condition for graduation. For example, one year with a freshman class of less than 1000 students, more than 600 students enrolled in beginning calculus. No more than 100 of these students came from supply departments. The issue of teaching algorithms vs. teaching thinking or concrete vs. abstract in mathematics education is not a problem at Potsdam College. Students consider the study of mathematics as an important part of a liberal arts education and not necessarily as a way of making a living using mathematics primarily. For example, some bachelor's in mathematics in the class of 1987 completed a second major in the following subjects: Anthropology, Biology, Chemistry, Computer and Information Sciences, Education, Economics, English, French, Geology, History, Political Science, Psychology and Physics. Also, they completed minors in the following subjects: American Politics, Business Economics, Business of Music, Directing, and Health Science.

The number of bachelor's in mathematics who entered Potsdam College with high school averages of 90 and above increased more than 9 times during the past 18 years. In our graduating class of 1987 more than 40% of the students who graduated summa cum laude or magna cum laude were bachelor's in mathematics. More than 50% of our undergraduate credits in mathematics are in post-calculus courses, while the national average is less than 10%. We have good cooperation from supply departments, our bachelor's in mathematics choose many different career options, and they are repeatedly hired by the same company or government agency as industrial mathematicians. They make many professional choices for graduate study.

A brief outline of the steps we took to establish our academic environment is given below.

Entering freshmen students with high school averages in mathematics of 90 and above, quantitative SAT scores of 550 and above, good general high school averages and aptitude test scores are invited to elect our honors calculus course during the fall semester of their freshman year without regard to their intended major in college. Each student is sent a personal letter of invitation. We make clear to students invited that they will not be penalized by the grades they will receive as a result of electing the honors calculus course rather than the regular calculus course. We explain that all students enrolled in calculus will be given the same final examination. Also, the teachers who teach an honors calculus section teach a regular calculus section and are well able to compare the achievement of students in different calculus sections.

From an entering freshman class of 1,000 students or less, we usually invite about 130 to 150 students. A little more than one-half of the students invited elect the honors calculus section. In the fall of each year, we usually offer two sections of honors calculus with an enrollment of 35 to 45 students. Some of the students invited who do not elect the honors calculus course do elect the regular calculus course. Many of our best mathematics majors complete our honors calculus course, although our mathematics faculty never discussed or made any particular effort to increase the number of mathematics majors.

We established in 1970 a BA/MA program in which able students can complete both the bachelor's and master's degrees in four years without attending summer school. Some of our most able students with advanced placement credit in calculus complete our courses in Linear Algebra I and Set Theory and Logic during the first semester of their freshman year. Students who do well in these courses are invited to apply for admission to our BA/MA program. We believe that a long period of preparation is not necessary in order to be successful in advanced courses in mathematics.

We do not give placement mathematics examinations in order to assign students to mathematics courses.

The Honors Calculus courses and our BA/MA Program give us an opportunity to recognize early our entering students, as well as their high school teachers, for their excellent academic achievement as high school students. We use our love and respect for the students we invite to lead them to an enjoyment of the study of mathematics, to understand the meaning of a mathematical proof and respect for a mathematical proof, to learn how to learn mathematics, to develop the ability to read a mathematics textbook for pure enjoyment, and to study indpendently. These students serve as role models to help us provide an intellectual climate where the mathematical potential of all students who elect to take mathematics courses in the Department can be identified and nurtured. Some of these students tutor in our mathematics lab and provide leadership in our large chapter of Pi Mu Epsilon. An opportunity to teach students in our BA/MA Program aids faculty members to teach mathematics courses close to their research interest.

Faculty members choose the teaching methods which have been most effective in maximizing the development of the mathematical potential of their students. While some teachers use the lecture method as their primary teaching method, others use many different methods of teaching which include the active learning method.

Each teacher has an opportunity to teach across the mathematics curriculum. Every effort is made to provide the most favorable working conditions possible for faculty members so that they can maximize their teaching effectiveness and professional growth.

The writer helped to develop a similar humanistic academic environment for learning undergraduate mathematics during the 15 years he served as chair of the Mathematics Department at Morgan State University, Baltimore, Maryland with similar success in the achievement of students in mathematics. Therefore, the writer conjectures that similar environments can be established in many colleges and universities. If such environments are established, perhaps over time, most of the lay public will no longer regard mathematics as its most hated and feared subject.

References

Gillman, Leonard - The College Teaching Scandal, From the President's Desk, Focus, Volume 8, Number 2, The Newsletter of the Mathematical Association of America, March-April 1988, Pages 2 and 5.

Henriksen, Melvin - Please Carry Your Coals to Where They Are Needed, Professor Stein; Humanistic Mathematics Network, Newsletter, Number 2, March 1988, Supported by a grant from the Exxon Education Foundation.

Kyrala, Ali - Concrete vs. Abstract in Mathematics Education, Notices of the American Mathematical Society, April 1988, Volume 35, Number 4, Pages 507-508.

Luttmann, Rick - The Basis for the Success of the Potsdam Program, Humanistic Mathematics Network, Newsletter, Number 2, March 1988, Supported by a grant from the Exxon Education Foundation.

Poland, John - A Modern Fairy Tale?, American Mathematical Monthly, 1987, Volume 94, Number 3, March 1987, Pages 291-295.

Romberg, Thomas A., Chair - Draft of the NCTM Curriculum and Evaluation Standards for School mathematics, National Council of Teachers of Mathematics Commission on Standards for School Mathematics, 1987.

Steen, Lynn A. - Mathematics in the Market Place, From the President's Desk, Focus, Volume 5, Number 3, The Newsletter of the Mathematical Association of America, May-June 1985.

Stein, S. K. - Gresham's Law: Alogorithm Drives Out Thought, Humanistic Mathematics Network, Newsletter, Number 1, Summer 1987, Supported by a Grant from the Exxon Education Foundation.

Clarence F. Stephens,
Professor Emeritus
Mathematics Department
State University of
New York, College at
Potsdam

CFS:pab
April, 1988