UME TRENDS

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Inside ...

Faculty Responsibilities in a New Era

Judith A Ramaley

Our colleges and universities are being asked to respond to new pressures from students, parents, legislators and funding agencies to demonstrate greater productivity and to document the impact of institutional programs and their relevance to the pressing needs of society today. At the same time, both Federal and state support for higher education is being cut back in order to direct scarce public resources toward other priorities such as public schools, corrections and public safety, and the cost of health care. The juxtaposition of these two trends requires colleges and universities to design creative new ways to accomplish their missions without the investment of new resources.

Until fairly recently, demands for greater productivity and greater outreach were felt primarily by administrators and trustees who then sent conflicting and sometimes contradictory signals to deans and departments. At research universities and institutions wishing to enhance their credibility and status, faculty have been told that they must obtain research support, teach morex students, and in some cases, concern themselves more directly with student recruitment, retention and success in order to promote larger enrollments.

In many cases where closer partnerships are being developed that link colleges and universities more closely with local public schools and community colleges, faculty are also being asked to participate in educational reform efforts or in collaborative projects with local organizations such as businesses and government agencies. In most instances, these new expectations and demands for greater productivity are falling upon the shoulders of faculty without any corresponding examination of what roles and responsibilities the institution explicitly or implicitly supports and rewards or any discussion of the impact of these new expectations on the faculty themselves.

Last year, the Joint Policy Board for Mathematics (JPBM) issued a report on "Recognition and Rewards in the Mathematical Sciences." In his foreword, Richard Herman, the Chair of the JPBM, described the situation clearly, "In institutions of higher education and in society, there is an implicit belief that scholarship, research and teaching are all valued. However, in practice, the measurement and rewarding of these activities is inconsistent and ill-defined."

The goal of the report was to stimulate debate and to offer an approach that institutions might use in upgrading the significance of teaching and outreach as valued faculty activities that an institution can recognize, support, evaluate, and reward.

Many of the new expectations and responsibilities that our colleges and universities are being asked to embrace will fall especially heavily upon faculty in mathematics. There are several reasons for this. It has become increasingly clear that mathematics and the sciences are "gate-keeping" disciplines. Students who lack competence in these fields will have limited options in selecting careers.

Many faculty are beginning to evaluate what has caused the unusually high failure rate in core mathematics courses and to institute much-needed changes in the curriculum. While laudable, these efforts, currently confined to the mathematics department, will soon be joined by much broader efforts to incorporate mathematical competence

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Decisions on UME Trends

With subscriptions continuing to lag, there is serious concern about the future of UME Trends. Decisions will be made during November and December about the status of the publication for 1996 and the long term future.

A strong influx of subscriptions would help decide to keep UME Trends going, but it has to happen right away. So please send in your subscription and get your colleagues to do so TODAY!

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The Emerging Scholars Program at U.C. Davis—A Recipe for Success in Engineering Calculus

Duane Kouba

Since it began in 1990, The Emerging Scholars Program (ESP) at the University of California, Davis, has been a highly successful, small-group, problem-based laboratory and lecture for students in first-year engineering calculus. It is patterned after the Mathematics Workshop Program created by Dr. Uri Treisman at U.C. Berkeley in 1978. ESP is open to all students at U.C. Davis, but approximately two-thirds of the participants are classified as SAA (Student Affirmative Action) or EOP (Educational Opportunity Program) and about 40% are women. Following is a description of the program and its effectiveness along with comparisons to a traditional Treisman model and other calculus courses offered at U.C. Davis.

ESP (6 credits) is one of the three engineering calculus options available to first-year students. They may also enroll in large lecture sections of calculus (4 credits) or small sections of honors calculus (4 credits). The ESP lecture component consists of three 50-minute lectures, where there are lectures, homework assignments, and exams comparable to those given in all other calculus courses.

The laboratory component of ESP is what sets this program apart from the other calculus classes available at U.C. Davis. It meets five hours per week—two 110-minute labs, and one 50-minute lab. There are no homework assignments or exams given in the lab, but each week a quiz is given in order to measure each student's weekly progress. Each student is allowed no more than three lab absences out of the entire quarter's 30 lab sessions.

Each ESP lab (there are presently two each quarter at U.C. Davis) has no more than 26 students and is staffed with one faculty member and one or two undergraduate teaching assistants (former ESP students), who are trained to facilitate the students' small group problem-solving, communication, and general interaction.

At the beginning of each lab, students pick up new worksheets containing a wide variety of calculus problems and solutions to the previous lab's worksheet, and begin working in pre-assigned, randomly-picked groups of three or four students. Lab worksheets are *independent* of the homework assignments given in the lecture class, and students are not allowed to work on homework assignments during lab time. In addition, math problems are written on the chalkboard in the ESP lab. Students may work in small groups or with classmates at the chalkboard, where other students can "watch them think."

In addition, students have at least one short 15-minute conference with the faculty member each quarter. This affords students the opportunity to discuss their progress in ESP, concerns with other classes or students, or any other personal or academic matters. The conferences give faculty members the opportunity to know the students in a more personal way, encourage them, and better meet their general needs.

This ESP model differs from the traditional Treisman model in a few subtle ways. However, these differences appear to be critical factors in the improved performance of student participants at U.C. Davis. First, the ESP lecture is a relatively small lecture of about 50 students (small by Davis standards) in the Fall Quarter. Thereafter, the students are merged into a large section of about 200 students. Second, the students are presented with many more problems than they can complete during lab time. It's a daily reminder that learning calculus is never finished, but is rather a broad, continuing process. Finally, and perhaps most importantly, each ESP lab is staffed with a dedicated faculty member who has many years of experience teaching calculus, interacting with students, and supervising assistants. It gives the program increased effectiveness and credibility and makes the students feel like an integral part of the Mathematics Department.

The success of ESP has been measured in several ways. Since all calculus students at U.C. Davis take the same final exam, this common exam allows for an effective comparison among the various calculus classes. During the 1993-94 academic year, the ESP students had the highest average performance on *each* common final exam when compared to both the regular, non-ESP calculus students *and* the honors calculus students, traditionally the highest performing group.

The Emerging Scholars Program has also greatly reduced the number of failures in first-year calculus and has also dramatically increased the number of those who improve markedly from Calculus I to Calculus III. Specific percentages for the 1993-94 academic year are:

	%D's & F's[1]	%A's from C's[2]	%C's to A's[3]	%worse[4]
ESP	4	47	31	22
non-ESP	23	10	3	63

[1] average % of D's and F's in calculus I, II, and II

[2] % of those who received an A in calculus III among those who had a C in calculus I

[3] % of those who received a C in calculus among those who had an A in calculus III

[4] % of those whose grade was worse in calculus III than in calculus I

The success of ESP suggests to me that the many efforts made to reform calculus—writing more "user-friendly" textbooks, teaching more "meaningful" applications, emphasizing writing exercises, etc.—may be missing the mark. Though all of these efforts can be applauded, I *strongly* believe that the critical factors in improving the performance of calculus students are an increase in the amount of time *faculty* spend with students and students' spending considerably more time doing calculus homework.

The ESP lab offers the time needed to patiently learn calculus and a stimulating, enjoyable environment in which to learn it. Because the ESP lab offers a loosely structured, self-paced learning environment, it is not just a place where students work on calculus problems, but where students form friendships and study groups, develop sound study habits (in many cases, for the first time) and communication skills, and learn how to think about problem-solving. The interaction encouraged by the program helps students develop a positive attitude toward mathematics in particular and learning in general.

The Emerging Scholars Program not only increased the survival rate of first-year calculus students, but has become a means by which average calculus students become outstanding calculus students.

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The Forest, the Trees, and Guided Discovery

Sherry L. Gale

Most mathematics textbooks are written in the axiomatic method format. Each new topic is introduced by stating definitions, an example or two, technical lemmas, and finally major theorems. This nice logical progression is the way mathematicians read and write. However, it is not usually the way we think and create. We have the big idea or result in mind first and then work to fill in the details. When mathematics is taught strictly in the axiomatic method format students easily get lost in the details and completely miss the big picture, "they can't see the forest for the trees". Many also seem to arrive at the erroneous and self-defeating conclusion that to succeed in mathematics one must think in this same style, starting with just the right small details that lead to beautiful major results. Emphasizing the big picture first and then working on the details, allowing students to make their own discoveries along the way, increases students' understanding and confidence levels. Below I give several specific examples of this top-down, guided discovery approach to teaching.

In most real analysis textbooks, the Cauchy-Schwartz inequality is proven and then this result is used to prove the triangle inequality. However, it is much easier to motivate and illustrate the triangle inequality first and its proof is easily begun by asking students to perform the initial routine algebraic manipulations. They soon get to a point where they need to know that for vectors p and q, $|p \cdot q| \leq |p||q|$, i.e., the Cauchy-Schwartz inequality.

Also in real analysis, function sequences are studied and examples are given to illustrate that a sequence of continuous functions may converge (pointwise) to a noncontinuous function. To guide students into discovering more about the problem with this convergence I ask them to work individually or in groups trying to prove the false statement, "the limit of a convergent sequence of continuous functions is continuous". Their proof attempt leads them directly to the definition of uniform convergence. The process of discovering the appropriate definitions and theorems to make the mathematics work trains students to think more like mathematicians and increases their understanding of and appreciation for mathematics.

This teaching technique is beneficial for a calculus course also. When teaching infinite series I begin by reminding students of the ease of working with polynomials and the importance of many nonpolynomial functions, e.g., trigonometric functions and exponential functions. I define power series and explain that many nonpolynomial functions can be written as power series, allowing for much the same ease of operation as experienced with polynomials. Initially we examine the simplest power series, the power series centered at zero with all coefficients equal to one, i.e.,

$s(x) = \sum_{n=0}^{\infty} x^n$. Students are asked to consider values for x which yield a finite sum. They see that values one or larger do not produce a finite sum and also conjecture that when $x = 1/2$ the series converges. Natural questions arise such as: How can we determine exactly the values of x for which a given series converges? Precisely what does convergence of a series mean? Series convergence is defined and then illustrated by examining the sequences of partial sums associated with the power series above for $x = 1$ and $x = 1/2$. Students are encouraged throughout the study of infinite series to keep focused on the forest of function approximation and to consider where each tree studied fits into the forest.

This type of top-down guided discovery discussion is typical of what can be done to introduce many new topics in calculus (or other courses). In Calculus I, before discussing limits, I introduce instantaneous velocity and ask students to consider how a position function might be used to compute instantaneous velocity. This leads naturally to the discussion of limits and the definition of the derivative. When introducing integration, I do not begin with a discussion of summation notation, but rather with a discussion of areas, in particular area under a curve and how one might approximate such an area. Students carry this discussion to its logical conclusion, the limit of Riemann sums. Then we back up a little and fill in the notation and theory details.

When describing this teaching method to colleagues they frequently question the pace of the course and/or the amount of material covered. Presentation of material in this format does take a little longer than it would take in a more traditional axiomatic method format. Thus not quite as many details are covered in class. However, in my experience the increased understanding gained by the students more than compensates. They are able to accomplish more outside of class, independently and in groups, so that the material learned is at least as great as it would be otherwise.

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newsletters provided a starting point for placement schemes. In spite of requests over the years for more prescriptive recipes for placement programs, local differences have made it impossible for the MAA to be more specific in describing placement schemes. After twenty years, some placement programs are very sophisticated and some are very simplistic. The tests, which are still published, are sometimes used as the sole instrument for placing students. Our experience with assessment programs is likely to be similarly diverse.

Bernie Madison of University of Arkansas is Chair of the CUPM Subcommittee on Assessment.