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Calculus Reform and the Revitalizing of Mathematics Education

by Robert S. Cole

Exciting new approaches to the teaching of mathematics in general, and calculus in particular, are being tested in Washington state. Many of these ideas are responding to the growing recognition of how poorly we've taught mathematics in the past. Through absorbing problem-centered curricula and collaborative learning structures, students are becoming engaged with calculus in inspiring ways. New forms of technology such as graphing calculators or computer software are also having a strong influence on the content and pedagogy in mathematics classes. This issue of the NEWS reflects the extensive work under way in the state to reform and revitalize mathematics at the collegiate level.

Continued next page

Participating Institutions: Antioch University, Bellevue Community College, Bellingham Technical College, Big Bend Community College, Central Washington University, Centralia College, City University, Clark College, Columbia Basin College, Eastern Washington University, Edmonds Community College, Everett Community College, Gonzaga University, Grays Harbor College, Green River Community College, Heritage College, Highline Community College, Lower Columbia College, North Seattle Community College, Olympic College, Pacific Lutheran University, Peninsula College, Pierce College, Saint Martin's College, Seattle Central Community College, Seattle Pacific University, Seattle University, Shoreline Community College, Skagit Valley College, South Puget Sound Community College, South Seattle Community College, Spokane Community College, Spokane Falls Community College, Tacoma Community College, The Evergreen State College, University of Puget Sound, University of Washington, Walla Walla Community College, Washington State University, Wenatchee Valley College, Western Washington University, Whatcom Community College, Yakima Valley Community College.

Robert Cole is a member of the faculty in physics at The Evergreen State College. (Photo: Steve Davis)

The Washington Center is playing a leading role in calculus reform. We were the recipient, in June 1991, of a National Science Foundation grant to initiate a statewide project to disseminate the best of the many calculus curricula being developed at a variety of institutions nationally. This grant, funded by NSF's Division of Undergraduate Education, has enabled us to involve twenty Washington campuses in calculus reform work. Janet Ray at Seattle Central and I serve as project co-directors.

The principal goal of our calculus project has to do with reform of the content and pedagogy of the calculus course itself. A second related goal involves disseminating information and establishing a network of mathematics faculty members within the state committed to sustaining curricular reform. We are interested in encouraging pedagogical methods that stress applications of calculus, use "active learning" strategies, emphasize collaborative student efforts, involve students in writing about mathematics, and use some of the new technology available for the teaching of mathematical concepts. We see the larger issues of *sustaining* curricular reform efforts as ones of organizational development and organizational change.

We are working closely with two nationally recognized reform calculus curricula, one developed by the Harvard Consortium, and the other by Duke University. These two projects are, in our opinion, the most robust of several national curricular experiments. They offer complete curricular visions, as well as intriguing uses of technology (calculators or computers) to foster learning. Collaborative learning modes are central to both curricula. However, we are not promoting any one curriculum as a "solution" for all campuses. Rather, each of our participating campuses is experimenting with, modifying, or adapting the Harvard or Duke models to their local institutional needs.

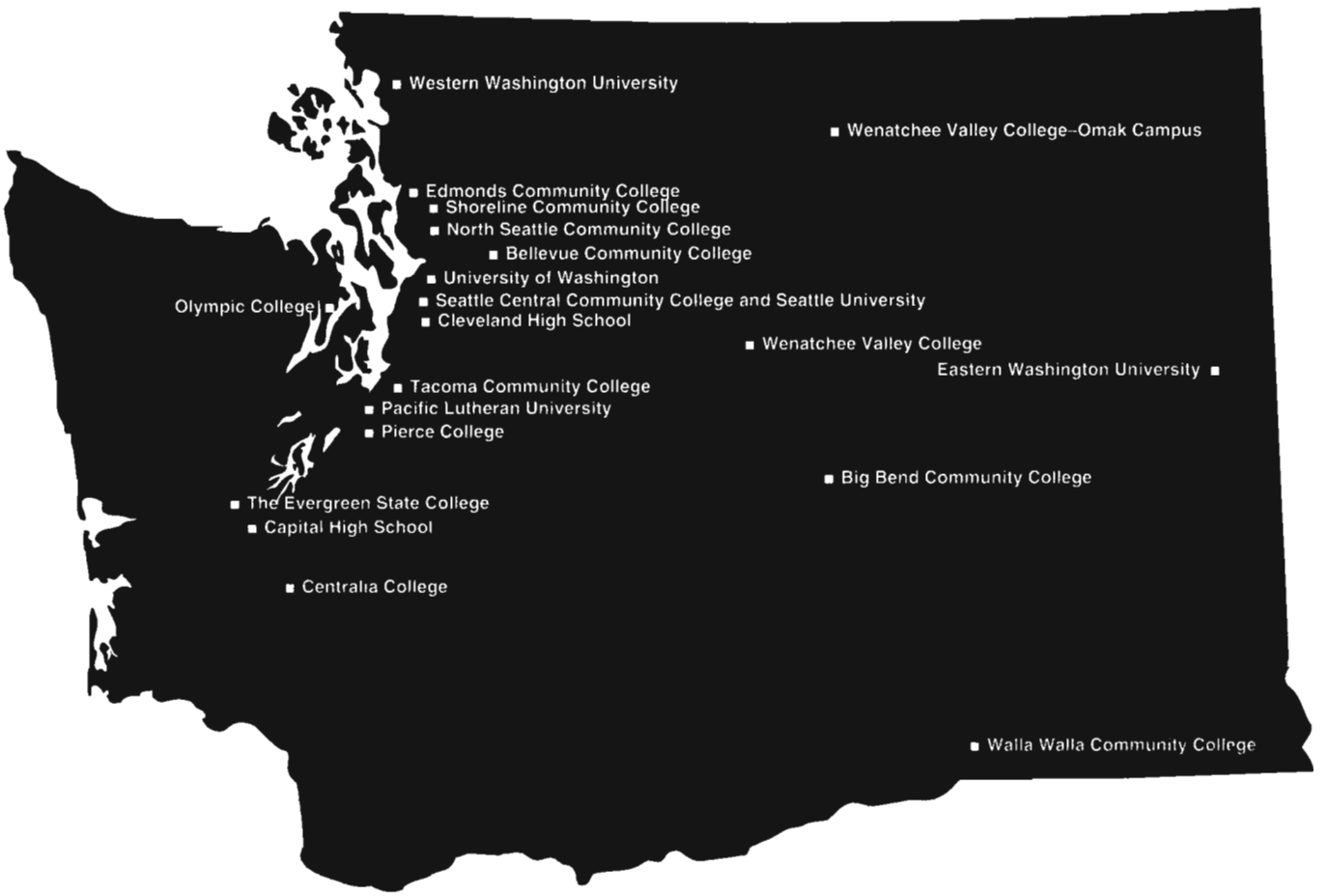
In the articles that follow, you'll see a variety of adaptations of curriculum and pedagogy being used by institutions involved in the Washington Center's calculus dissemination project. Experiments with new approaches and techniques continue to flower. The sharing of these rich and diverse experiments is adding new vitality to mathematics departments, and this spirit is spilling over into other courses, both lower and upper division. Students and faculty alike are *engaged* with mathematics in new and provocative ways. We hope this issue of the *NEWS* will stimulate your thinking and discussions about calculus and mathematics reform.

Happy reading,

Robert Cole

Robert S. Cole
Guest Editor
and Member of the Faculty
The Evergreen State College

Campuses participating in the Washington Center Calculus Project.



Why Should We Care About the Teaching of Calculus?

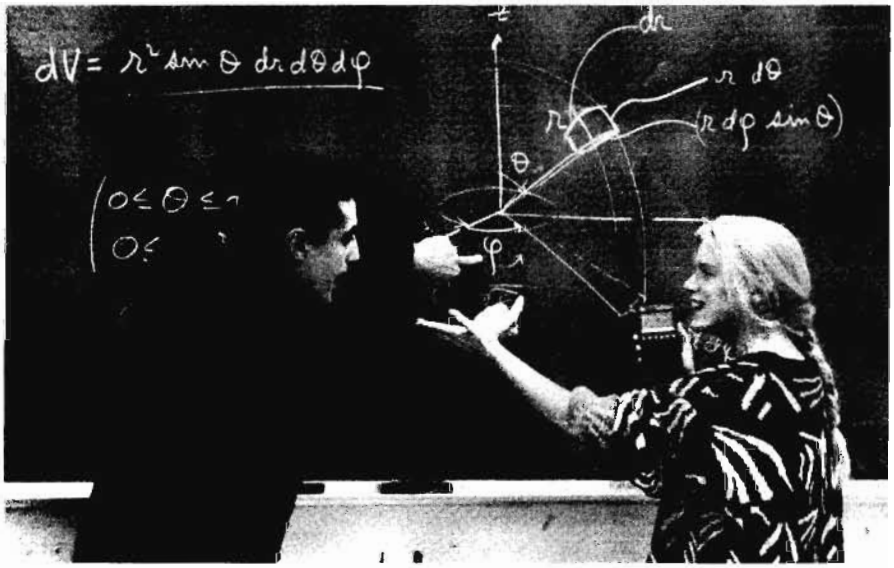
by Robert S. Cole

"Calculus is a college course I took twice, to get through once, and still never understood." One of our Evergreen colleagues, Terry Elliott, speaks for many of us, no doubt, in that one damning sentence about his memory of calculus. The actual experience of taking calculus is usually recalled as painful, baffling, demoralizing, humiliating, and torturous. How many people changed majors, or left college entirely, because they couldn't cope with the frustration and loss of self-esteem accompanying the experience of taking a calculus class? Lorene Cary, in her autobiographical book, *Black Ice*, about being an African American student in an elite prep school, recalls her encounter with calculus this way.

"Mr. Hawley's end-of-term letter arrived with my grades. I had failed calculus. ... I would have to gather the strength to hurl myself at it once more. It was a two-term course. I could still pull it off. If only I could stand the pain of not understanding a little longer, the magic would happen. ... I continued to flail about in calculus. I cursed myself for ever having signed up for it. I cursed my teacher and made nasty jokes about him at the table. I completed my homework assignments with grim determination, and emerged from each one as baffled as I had begun. ...I whipped myself into a frenzy, hoping that pressure and panic would hasten learning, but with each new lesson, I fell further behind."

Calculus Reform Takes Shape

Few courses in the academy have provoked such universal anxiety and such widespread failure as calculus. But it wasn't until the 1980's that mathematics educators began to acknowledge that calculus classes weren't working. They were failing to train students to appreciate or use mathematics, failing to inspire students to take additional mathematics courses, failing to meet the needs of other disciplines that required students to take calculus, and failing to convey that any of the content of mathematics had changed in the last century and a half.



Active learning and collaborative work are hallmarks of calculus reform. Here, students Charles Torre and Kristin Alvarez argue over a spherical volume elements problem in the Physical Systems program at Evergreen. (Photo: Robert Cole)

"Few courses in the academy have provoked such universal anxiety and such widespread failure as calculus."

Calculus was a barrier or a filter to winnow students out of majors. A Sloan Foundation-sponsored conference at Tulane University in January of 1986 initiated what has become a national movement to create a "lean and lively" calculus. It would prune back massive texts and concentrate on central concepts in calculus. It would enliven calculus content with problems based in the real world. At a "Calculus For a New Century" Colloquium in Washington, D.C. in October 1987, reformers argued that calculus should and could be a pump—not a filter. Shortly thereafter, the National Science Foundation began funding the development of detailed curricular models to translate these ideals into working courses. The Washington Center Calculus Project is an effort to disseminate two of these reform curricula, the Harvard Consortium Curriculum and Duke University's Project CALC, to colleges and universities within the state.

So What Exactly is Reform Calculus?

...and how does it differ from the more traditional forms? Most of the reform calculus curricula have the following characteristics: (1) they stress *applications* of calculus to "real world" situations, (2) they use various *"active learning"* strategies, rather than rely on traditional lecture methods, (3) they emphasize *collaborative student efforts* in both in-class group activities, and out-of-class group projects, (4) they ask students to *write* about mathematics in order to deepen conceptual understanding, and (5) they use *technology* such as graphing calculators and computer software as an integral part of the teaching of mathematical concepts. Readers familiar with the work of the Washington Center will recognize familiar pedagogical themes here.

But the content of the calculus course has also undergone a change. When most of us took math in college, algebraic symbolic manipulation was stressed. Reform calculus still teaches symbol manipulations, but it also places equally strong emphasis on interpretation of numerical data, graphical representation of information, and written description of the concepts involved. Reform calculus de-emphasizes symbolic manipulation precisely because graphing calculators and computers now do it so well, and because asking students to think in multiple ways about mathematics helps them deepen their understanding of it.

While most traditional calculus curricula are about answers (and how to get them), many reform calculus curricula are about *questions*—questions about the world around us. It is the focus on important, real world questions and applications that students find so engaging. Since calculus is in fact the mathematical language of motion and change, it can provide important insights into models of disease spread or control, it can address questions about which resources humans might exhaust first—food, energy sources, or living space, and it can offer insights into

Seattle Central Community College students Herenessa Aetonu and Lawrence Paulman move theory to practice as they take measurements of a mass on a spring. (Photo: Bob Hereford)

"...asking students to think in multiple ways about mathematics helps them deepen their understanding of it."

systems that cause things to flow in a network, whether they be transportation systems or cash flow systems within a community.

Questions regarding these topics captivate students in ways that the prototypical rowboat-offshore-of-the lighthouse, or canoe-moving-cross-stream problems of the past never could. But real world problems seldom have straightforward "closed form" solutions. As David Smith of Duke University says in his introduction to the excellent textbook *The Calculus Reader*, "Indeed, answers that fit neatly in books are seldom real solutions to real problems."

Hence tremendous emphasis in reform calculus classes is placed on interpreting numerical data, and graphing relationships that are rarely described by pure circles, parabolas or sine waves. Messy, real world data becomes the raw material of the new calculus.

Some Implications

Small wonder then that many reform calculus courses have laboratory sections—laboratories that go beyond mere computing rooms. Millie Johnson at Western Washington University has her students take a variety of measurements of things that move and change. The mathematics department at Seattle Central Community College has purchased Physical Science Laboratory (PSL) measuring probes that are fully integrated computers for data analysis and display. The Matter and Motion laboratory at The Evergreen State College allows students sufficient time to actually *explore* various physical and chemical systems and then analyze and interpret the results with the computers at hand.

Students are clearly more engaged with these new approaches. Faculty member Steve Perry at Shoreline Community College says, "I like walking into class and finding groups of students enthusiastically engaged in discussion of fundamental concepts."

At Pierce College, faculty member Diane Downey states, "I am pleased with the willingness, even eagerness, with which students grapple with new and unfamiliar problems", while her colleague, Jim Erickson, reports enthusiastically, "In the past my calculus students adhered to the five-minute problem-solving method (if a problem couldn't be solved in 5 minutes, go on to the next one). It is exciting to see my present students developing a problem-solving ethic. They now have the courage, experience and enthusiasm to solve challenging, real-world problems."

These results are important. Students are suddenly seeing calculus as not only useful but exciting. This can't help but have a positive impact on students in a variety of disciplines. We suspect if these reform efforts work, then calculus won't be the last mathematics class students take, and won't be the unpleasant experience too many of us remember.

FOOTNOTES:

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* **Mathematical Association of America,** 1529 Eighteenth Street NW, Washington, D.C. 20036-1385. Telephone: 202-387-5200.

20 Questions

that Deans Should Ask Their Mathematics Department

(Or, that a sharp department will ask itself.)

by Lynn Arthur Steen

Lynn Steen, on leave from the mathematics department at St. Olaf College, Northfield, Minnesota, is the Executive Director, Mathematical Science Education Board, National Academy of Science. (Photo: St. Olaf College)

"Yet more than any other subject, mathematics serves as a filter, enhancing or blocking access to professional careers in a manner that has disproportionately negative consequences for women and minorities"

Mathematics has been described as an "invisible culture," one that exercises profound influence on all aspects of society — from engineering to economics, from strategic planning to political polls. Yet it is shunned by many adults, avoided even on campuses, where students, faculty, and administrators will expend great energies arguing about general education reform while ignoring the less glamorous yet equally important educational policy issues surrounding the university's mathematics curriculum.

Make no mistake about it: the learning of mathematics entails profound sociopolitical consequences. Success or failure in mathematics determines access to courses and curricula that lead to positions of influence in society. The increasing role of technology in the world of work amplifies the already strong signal sent by the scientific revolution that the language of mathematics is an essential component of literacy for our age.

At its best, education can be the equalizer of socioeconomic differences. Yet more than any other subject, mathematics serves as a filter, enhancing or blocking access to professional careers in a manner that has disproportionately negative consequences for women and minorities. When students drop out of college for academic reasons, the culprit is often mathematics—not just because of one poor grade, but because failure in mathematics prevents further progress in so many other subjects.

For years, educators assumed that this was just in the nature of things—mathematics learning was the result of genetic and cultural factors that predisposed certain people to success and others to failure. This belief endured—and still persists—despite significant evidence that it simply is not true. The record of many small colleges (especially women's colleges and historically black colleges), the success of special intervention programs at various universities, and evidence from educational research make it clear: For the traditional lecture style is effective only for students who arrive with uncommon levels of motivation and persistence; most students learn better with more active, varied modes of instruction; and virtually all students can succeed in mathematics provided they are placed in and supported by an appropriate community of learning.

There is no longer any excuse for excessive failure rates in college mathematics. Examples abound of ways to improve success rates for all students, even for those with poor mathematics preparation. Although effective programs might appear initially to cost more than ineffective ones, the benefits of success—in reduced repetition of courses, in improved retention and graduation rates, in increased opportunities for students—far outweigh the visible costs of these programs. In some cases, effective programs can actually be less expensive overall.

Asking is the First Step

Deans and provosts who wish to improve mathematics education on their campus need to recognize two realities:

- Mathematics *can* be learned by most students.
- The cost of failure is often higher than the cost of success.

Armed with these convictions, they can begin the process of self-renewal by posing to their mathematics department a series of critical yet frequently unasked questions:

About Students

Who are your students? Does the department know, systematically and in useful detail, who its students are and why they are in its courses? Students who enroll in college mathematics courses arrive with amazing mixtures of aspirations and anxieties, often exaggerated, always intensely personal; student attitudes toward mathematics frequently have more influence on performance than do remembered skills or school-based learning. A first step toward improved success is a good, up-to-date understanding of the preparation and motivations of the students.

Are you committed to teaching the students you have? It is all too easy for faculty to covet students who fit an imagined mold of young scholars created in the faculty's image, or to treat every first-year student as a potential mathematics major. Instead, the department's priorities should match the actual student population. Instructional practice based on false assumptions yields disillusionment for both students and faculty. Effective instruction harmonizes the goals of the institution with the expectations of its students.

Do you believe that your department should educate all students? More concretely, does the faculty believe that all students can learn mathematics? Does the department offer appropriate and appealing courses that meet the needs of all students who enroll in the institution? Does the faculty apply as much creative energy to improving the most elementary courses (those often termed "developmental" or, more derisively, "remedial") as it does to the advanced? In fact, the "simple" courses might be the most important in the long run: Most mathematics used in the world, after all, is just simple school mathematics applied in unusual contexts.

Do you have explicit goals for increasing the number of students from underrepresented groups who succeed with mathematics courses? Vague intentions with explicit goals are too easily ignored. There are precious few departments of mathematics in the country whose record of success with black, Hispanic, and other underrepresented groups could not be significantly improved. Any goal must be specific to the institution, but surely one aspiration must be that mathematics becomes a pump rather than a filter for students who have been traditionally underrepresented in the professional fields that build upon college-level mathematics.

What do your students achieve? More specifically, how does the department know what its students have really accomplished? End-of-term exams generally reveal only short-lived mastery of procedural skills. Does the faculty have any evidence about broader objectives or longer-term learning? Does the faculty ever ask students to solve authentic, open-ended problems, or to write, read, or speak about mathematics? Do courses provide opportunities for students to learn anything other than textbook-based template exercises? To what extent are course grades based on an examination of these broader goals of mathematics education?

Do you know what happens to students after they leave your courses? Do students who take mathematics courses go on to use their mathematics in subsequent courses? What mathematics? How well? What about students who drop out or fail: Have they given up on mathematics, or do they return and succeed in subsequent courses? Do students who receive good grades find that what they learned serves them well in subsequent courses? Does the department have a mechanism for adjusting curricular emphases based on feedback from students who have taken its courses?

"Regular faculty seminars on issues of curriculum, teaching, and learning help create an environment of faculty attention to learning that is crucial to student success."

About Curriculum

Do your departmental objectives support institutional goals? Despite variations in rhetoric, widely shared goals for mathematics education are entirely consistent with broad goals of higher education: to develop students' capabilities for critical thinking, for creative problem solving, for analytic reasoning, and for communicating effectively about quantitative ideas. Yet the implicit objectives of many mathematics departments, as inferred from curricula, exams, and student performance, are often focused on mastering relatively sophisticated yet intellectually limited procedural skills. Departments must express for themselves—and even more so, for their students—how their course objectives advance their institutions's educational goals.

Do your courses reflect current mathematics? Since mathematics is such an old subject, it is all too easy for its curriculum to become ossified. Strong departments find that they replace or change significantly half of their courses approximately once a decade. As new mathematics is continually created, so mathematics courses must be continually renewed. Does the mathematics curriculum reveal to students a level of innovation and attractiveness that reflects the excitement of contemporary mathematical practice?

Are you aware of the new NCTM *Standards* for school mathematics? More importantly, is the faculty making plans to provide an appropriate curriculum that builds on the foundation of the National Council of Teachers of Mathematics Standards, following their spirit as well as their content? Colleges must be prepared for students arriving with increasingly disparate backgrounds—many from traditional authoritarian, exercise-based courses, but an increasing number of others fresh from an active, project-centered approach that typifies NCTM's new school *Standards*. It would be ironic, indeed tragic, if intransigent college mathematics departments were to hold back reform of school mathematics by refusing to adapt to the new reality of a more diverse and powerful secondary school curriculum. (See footnote, below.)

Are calculators and computers used extensively and effectively? Beginning with placement exams and continuing all the way through senior courses, calculators and computers should be used in every appropriate context. Since the mathematics used in the scientific and business world is fully integrated with calculators and computers, the mathematics taught in college must reflect this reality. Anything less shortchanges students, parents, and taxpayers.

Does your curriculum meet the post-graduation needs of your students? Does the department know what its majors do after graduation? How many take jobs in which they use their mathematics training? How many enter secondary or elementary teaching? What about graduate school—in mathematical sciences, in other sciences—or professional school? Does the students' mathematics education adequately prepare them for those experiences?

How does your program help students see the ways mathematics connects to broad issues of human concern? Specifically, does the mathematics faculty and its courses connect mathematics to student aspirations, to liberal education, to other disciplines? Does the program empower students to think and act mathematically in broad contexts beyond the classroom? Unless this happens, students feel cheated by lack of reward commensurate with the effort required.

About Faculty

How does the scholarship of your faculty relate to the teaching mission of your department? Does the faculty subscribe to a narrow view of research or to a broad perspective on scholarship? Traditional standards of mathematical research make direct connections to undergraduate teaching rather difficult, whereas a "reconsidered" view of scholarship opens doors to constructive engagements in which faculty can thrive professionally and students can become junior colleagues. Does the department both expect and support professional development in its varied forms? Is the department committed to offering all of its majors suitable professional, scholarly, research, or internship opportunities?

What steps have you taken to be sure your faculty is well informed about curriculum studies and research on how students learn? Part of the professional responsibility of faculty is to know the scholarship that undergirds college teaching. Everyone has opinions about curriculum and pedagogy, but professionals need to support their opinions with evidence. Since graduate education in mathematics rarely provides an introduction to this arena of scholarship, departments must accept it as part of their responsibilities. Regular faculty seminars on issues of curriculum, teaching, and learning help create an environment of faculty attention to learning that is crucial to student success.

What are your priorities for teaching assignments? In particular, does the department assign its best teachers to beginning courses? Are courses for non-majors given the same priority as those for majors? Does the faculty prefer students who learn without being taught, or those who challenge teachers to teach effectively? How do rewards reflect the teaching challenges faculty undertake? Is the quality of teaching measured by the good students the faculty attracts to its courses, or by the learning of all students in those courses?

Is your faculty fulfilling its responsibility for the preparation and continuing professional education of teachers? NCTM's new *Standards* for school mathematics include clear expectations for both content and pedagogical style in the mathematical preparation of school teachers at all grade levels. How many members of the mathematics department are familiar with those expectations? To what extent do courses conform to those *Standards*? What steps is the department taking to ensure that all mathematics courses for prospective teachers meet appropriate professional expectations?

How are faculty resources allocated between courses that serve the major and those that serve general education? Typically, 80 percent of the students in a mathematics department are enrolled either in service courses or in general-education courses. Often that 80 percent of students commands only 20 percent of faculty time and energy. Yet it is those students who will go on to be future policy leaders of society—members of boards of education and city councils, editors of local newspapers, leaders of Chambers of Commerce.

At last summer's Washington Center calculus dissemination workshop, University of Arizona's David Loman posed these same "20 questions" to the participants. Loman and the U. of Arizona are partners in the Harvard Consortium Calculus Reform effort. (Photo: Jean MacGregor)

About Costs

Have you calculated the true cost of the status quo? Courses staffed on the cheap (the "cash cow" approach to funding mathematics departments) result in students repeating courses, failing related science courses, or dropping out of college altogether. Students who succeed in their first college mathematics course are far more likely to succeed in college than those who do not. Cheap courses are not necessarily as cost-effective as they appear.

Are you aware that mathematics departments exercise disproportionate influence over an institution's graduate rate? A small increase in the percentage of students who complete mathematics courses with a well-earned sense of accomplishment can translate into higher graduation rates in many disciplines that depend on mathematics. Conversely, any decline in the success rate in first-level mathematics courses cascades into even higher drop-out rates by students who find themselves lacking pre-requisites for key courses in their majors.

What resources do you require to achieve your objectives? At the end, this might be the most important question of all. Mathematics cannot be taught successfully without resources adequate to the task. Many mathematics departments also suffer from inefficient distribution of their existing resources. In return for a prudent self-study by a department of mathematics, the institution should be prepared to commit resources to promising new approaches in which the cost of success compares favorably with the cost of failure.

Invest for Success

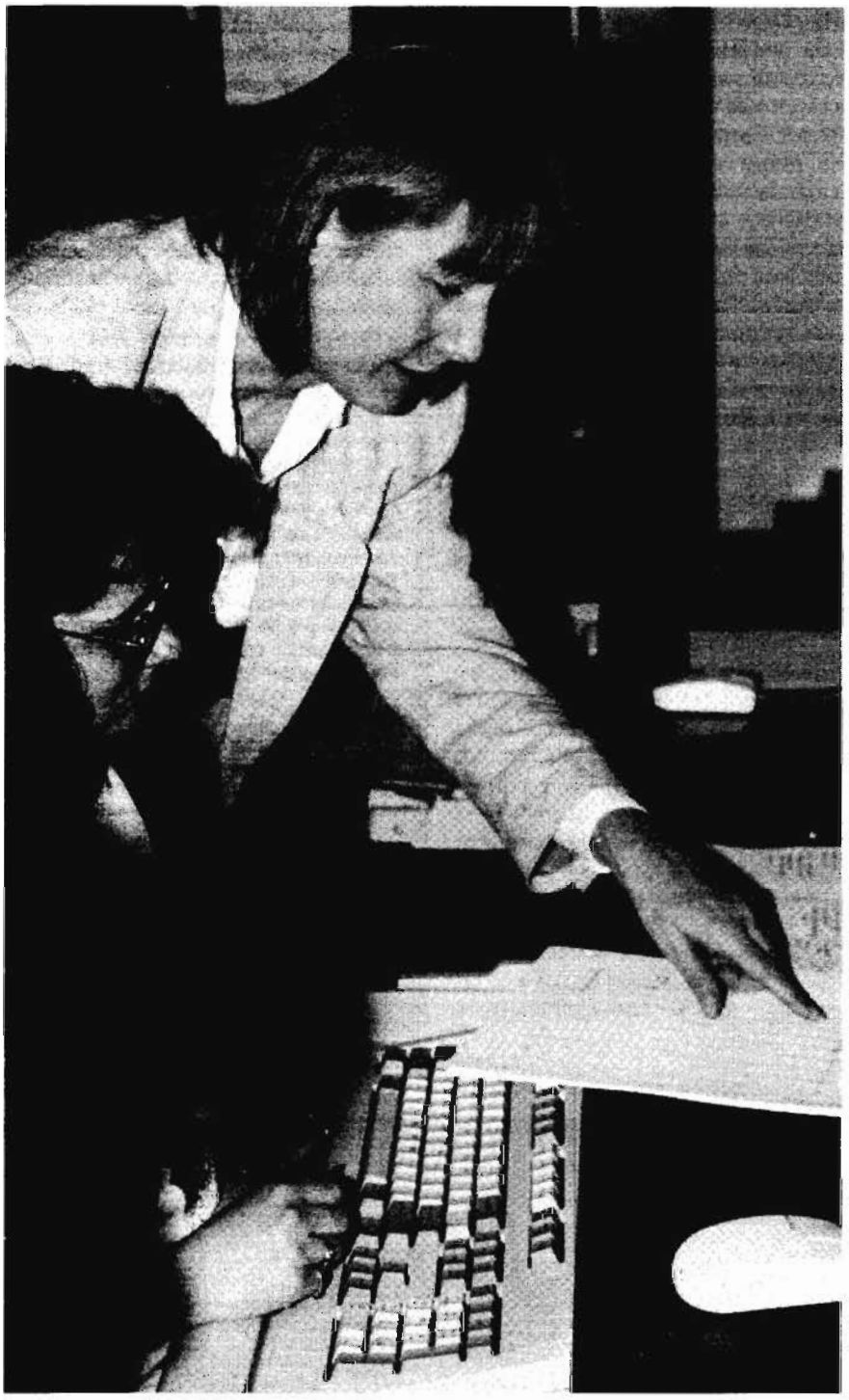
The spotlight of national attention that has been aimed at mathematics and science education has revealed not only weaknesses in the present system but also outstanding examples of success. Mathematics need not remain a barrier to further education. Investment in programs that make possible increased success in mathematics provides great leverage for any institution that wishes to improve the overall education of its students.

Footnote

The 1989 NCTM publication *Curriculum and Evaluation Standards for School Mathematics* lays out a framework around which curricula should be built. A 1991 companion volume, *The Professional Standards for Teaching Mathematics*, describes how teachers should implement those curricula. Either book is $25; the set is $42.50. To order, call the National Council for the Teaching of Mathematics toll-free 1-800-235-7566.

[This article originally appeared in the American Association for Higher Education AAHE *Bulletin*, May 1992. Reprinted with permission from AAHE and the author.]

Collaborative work is the norm in Seattle Central Community College's mathematics computer science classroom. Here, instructor Mike Pepe works with a student team. (Photo: Bob Hereford)



Olympic College mathematics instructor Ann Brackebusch and student Heather Carter, using computers to illustrate calculus problems. (Photo: Jo Albertson)

Initiating Reform at Olympic College

by Ann Brackebusch

"Students commented, sometimes in exasperation, 'You're expecting us to think!'"

Olympic College math faculty members have a long history of modifying math courses to include realistic and interesting problems. Our search for materials to support these efforts led Martin Haines and me to attend the first workshop of the Washington Center Calculus Project in the summer of 1991. We were impressed with a variety of new approaches about which we learned—so impressed that we made changes in our own calculus courses starting that Fall.

Although we had very little planning time, we decided to pilot the Harvard text in selected sections of the first and second quarter calculus classes. While the students in these sections purchased the traditional textbook, Olympic College agreed to xerox copies of the Harvard materials for the students free of charge. [*Editor's note:* the Harvard Consortium granted permission for its preliminary calculus text to be reproduced for experimental use at all the campuses involved in the Washington Center calculus project.] In addition to the extra handouts from the Harvard project, students in these pilot classes were also required to do group project problems modelled after the Duke University calculus labs. These project problems required using computers as a tool in the solution process. The software choice was *Lotus 1-2-3*, which the college had already installed in the student laboratories.

The very different approaches of the two textbooks created difficulties for the students—most of them found the Harvard materials to be more engaging, and more germane to their own experience, but strange and, at times, simply difficult. Students commented, sometimes in exasperation, "You're expecting us to think!"

We faculty were experiencing our own difficulties: the new approaches were vastly more demanding of our own time, and some of the new pedagogical approaches left us feeling as if we were swimming in unfamiliar waters. Many of our assumptions about mathematics teaching were brought into question. We had to learn new skills of managing groups and working with students on their writing. We had to give up some of our control in the classroom. The students challenged us regarding the materials. They worked hard and often came up with creative ways of interpreting mathematics. They read the text, they argued about it, they worked together at the computer, they hammered out solutions, and they wrote up great projects. They were using calculus in a thoughtful way.

Initially we weren't sure how extensively we would use the Harvard materials, but as time went on we gained more confidence. By the end of Winter Quarter, the students helped us decide which way to proceed for the following academic year. They preferred the Harvard approach to the traditional one. Several students referred, rather acidly, to the traditional text as a $70 table of integrals! We got the message. Beginning in Fall of 1992 the Harvard text was the required text for the first two quarters of calculus at Olympic College.

"We faculty were experiencing our own difficulties: the new approaches were vastly more demanding of our own time, and some of the new pedagogical approaches left us feeling as if we were swimming in unfamiliar waters."

[For further information, contact Ann Brackebusch at Olympic College, 206-478-4539.]

Realistic Problem-Solving in Large-Scale Scenarios in Calculus Classes

by Carl Main and Betty Hawkins

At Shoreline Community College, several of us on the mathematics faculty have been experimenting with writing "scenarios," complex stories that are the context for series of mathematical problems during the quarter. Typically we use eight or nine problems (about one a week) that create an unfolding story. We hit upon this approach because we saw how "real world" problems in the Harvard calculus curriculum engaged the students. In short order, both the students' enthusiasm and ours led us to augment the Harvard textbook. Our ideas have evolved over time, as have the scenarios.

Students form teams of two to four at the start of each quarter. We ask them to work as a task force of a consulting firm employed to solve problems for an imaginary client from the scenario. As the weekly problem from the scenario is posed, each team tackles it, writes a report to the client, and provides explanations in graphic, numerical and verbal forms. Students become remarkably involved in these scenarios. The stories and the rich, puzzling problems stimulate students' imagination, creativity and sense of fun.

One scenario placed the students in the construction business, working for the estate of an eccentric billionaire. One of their first tasks for the client was to plan the construction of a road through the estate. The shape of the estate, the river running through it, and the shape of the road were given by mathematical equations, and the students were to determine the location of the entrances of the road to the estate, and the site where they would build a bridge over the river.

As the quarter progressed, details about the scenario and new problems unfolded. In fact, we drew on ideas from the students' written reports to expand and embellish the scenarios. Using increasingly sophisticated calculus concepts, students' reports to the "eccentric client" involved stained glass window designs for "the mansion," tree plantation schemes for the formal gardens, and power line location (as illustrated here).

Toward the end of the quarter we asked students to write problems of their own based upon the scenario. Each team gave an oral presentation to the class of a solution to one of their own problems. Several of these presentations were fine combinations of mathematical technique and wit. Student enthusiasm for this type of work flourished.

In subsequent quarters we developed different scenarios involving a large airplane manufacturing company, and then another about a kite factory situated at a seacoast beach. We continue to experiment with scenarios and problem-solving teams as a means of engaging students in calculus.

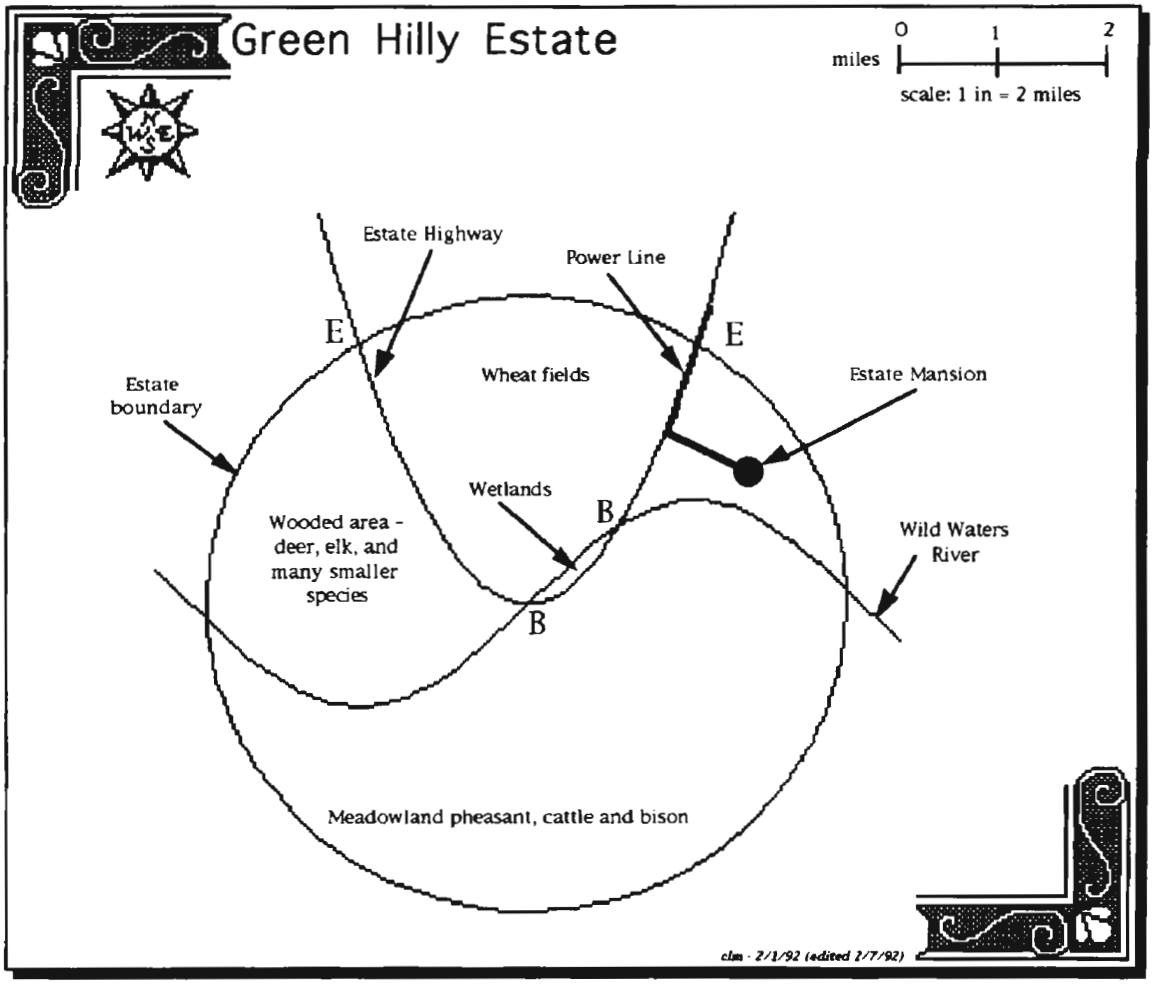
Because the problems in the scenarios are realistic, the data is seldom simple. Working with the data is messy and complex. Technology is critical here because students need to perform computations with "messy numbers," without getting bogged down in lengthy calculations. We use *Theorist* and *True Basic Calculus* as the primary software packages. Two or three former students who are skilled in the use of the hardware and software work in the lab each week. We also encourage (but do not require) students to acquire graphing calculators for their work at home, with their teams, and in taking tests in class.

We believe this approach develops good skills in problem- solving. Students have become effective in team-work, and show excellent insight in their interpretation of results. We are encouraged by the preliminary returns from our efforts, and plan to increase the number of sections and the number of faculty who are using this problem-centered approach.

[For further information, contact Carl Main at 206-546-4739 or Betty Hawkins at 206-546-4600 at Shoreline Community College.]

"Technology is critical here because students need to perform computations with 'messy numbers,' without getting bogged down in lengthy calculations."

Problem 3. The Power Line Problem. The power line to the Mansion will come from the local Public Utility District with the power line entering the estate at the North East Gate. The Estate must bear the cost of placing the Power Line in place on the Estate itself. The line costs $2000 per mile to install along Estate Highway and $10,000 per mile to install going across the Great Park to the Mansion itself. The Mansion is located at a point 2 miles East and 1.5 miles North of the South Bridge. The Mansion is exactly 2.5 miles from the South Bridge. Design the layout for the Power Line that requires the least installation cost to the Estate.



One of the Green Hilly Estate problems posed by Shoreline Community College mathematician Carl Main.

"The stories and the rich, puzzling problems stimulate students' imagination, creativity and sense of fun."

Janet Ray, mathematics instructor at Seattle Central Community College, and the co-director of the Washington Center calculus dissemination project. (Photo: Lucy Hart)

Mathematics Program Reform at Seattle Central – A Case Study

by Jan Ray, Seattle Central Community College

About five years ago the mathematics faculty at Seattle Central Community College began a process that has fundamentally transformed the courses we teach. At the outset, I don't think the scope of the changes were purposeful or entirely anticipated. However the challenges we encountered in making mathematics both accessible and attractive to a diverse population of adult learners did not lend themselves to halfway measures.

What We Noticed

We recognized that even very able students were often terminating their mathematics study at the last required course. We were not doing a good job of conveying the excitement of mathematical ideas, of convincing students of their own ability to succeed, or in demonstrating that quantitative skills can produce useful answers to interesting questions.

Moreover, students who did continue often could not reliably use their mathematical training to produce reasonable answers to real problems. They might be able to manipulate algebraic symbols, but they fell short when asked to apply these skills thoughtfully and creatively.

We also sensed that conventional approaches to remediation had serious shortcomings for adult learners. First of all, community college students who arrive lacking basic skills have already experienced some brand of standard mathematics instruction that just didn't work for them. Secondly, they are in a hurry. Those needing to start at the lower levels became understandably impatient they are told it could take up to six quarters to get ready for calculus.

"We came to believe that learning environments where students solve problems and construct meaning together enhances learning."

What We Did

It was significant that several members of our math faculty at Seattle Central had recently taught in learning community programs stressing interdisciplinary study and collaborative learning. We came to believe that learning environments where students solve problems and construct meaning together enhances learning. We also began to see that studying fewer topics in greater depth can produce more profound intellectual development, and that studying ideas in context promotes greater subject coherence.

Consequently we began by identifying what we believed were "core" topics and themes in each of our standard math courses. We then focused on developing materials that require students to actively explore these ideas in the setting of a "real" world model. We encourage exploration with rulers and compasses, protractors and scissors. We bounce balls, drop grapefruit, time damped springs, and fill cylinders with beans and rice. We work with data and graphs in addition to idealized models. And, since the college resides on Seattle's Capital Hill, we have asked every conceivable question there is to be asked about the "latté stand" business.

In addition, the physical arrangement of our classrooms has changed to enhance small group activities. Tables of three to four students, or table armchairs pulled in a circle, allow collaboration on projects and worksheets. Lectures still have a place in our teaching, but are no longer the primary means of promoting learning.

We have also sought to merge our use of emerging technology with our commitment to collaborative learning. The skilled use of a computer algebra system—we use *Derive*—or the use of graphing calculators, now plays some part in most of our

courses and affects our decisions about both content and methodology. Using technology, students work as teams on problems often inaccessible to mathematical beginners. We believe such experience is good preparation for doing mathematics in the workplace and surprisingly, it seems to motivate learning to do algebra "by hand." Most importantly, it allows students with weaker skills in numerical symbol manipulation to experience the excitement of answering difficult and meaningful questions.

In addition, we have developed a unique and powerful "express course" to prepare students headed for calculus. This ten-credit block of coursework in beginning and intermediate algebra meets two hours a day, five days a week and covers the material normally contained in two consecutive courses. We've carefully chosen courses with some overlapping content which allows sufficient time for the central ideas, while providing an opportunity for enriched experiences. It also permits students to focus their energies more selectively on their mathematics and to establish a more cohesive learning community.

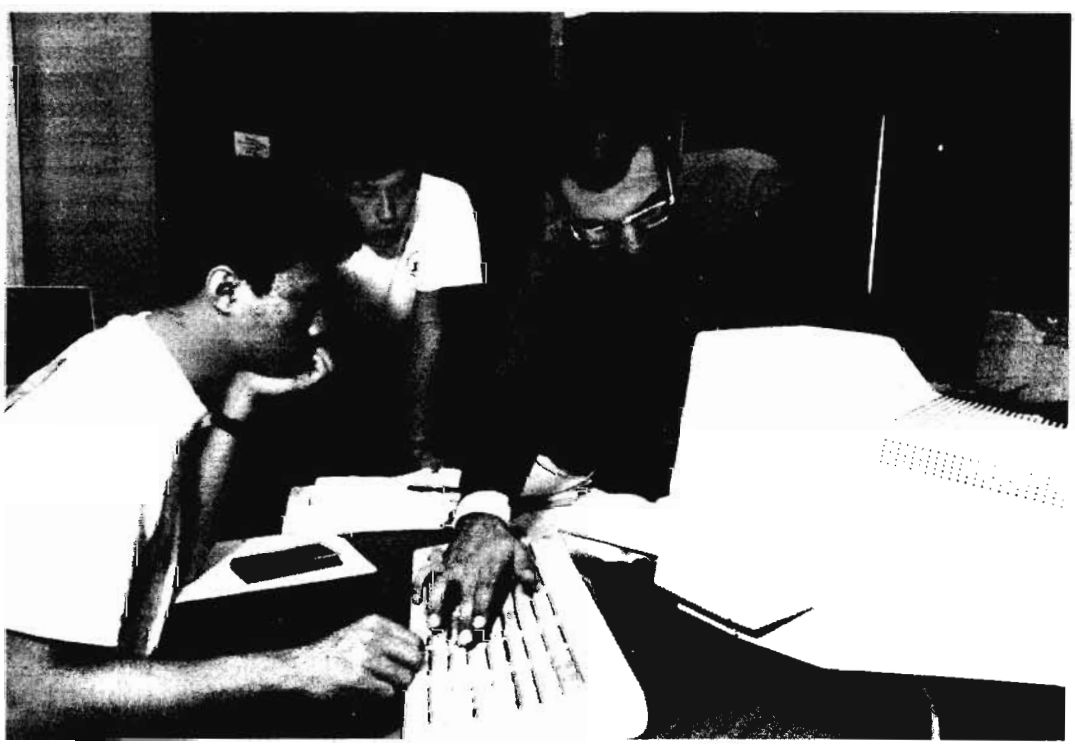
Results

Preliminary results indicate that some combination of these strategies are working. The percentage of students taking a math course beyond the required ones is increasing. And we are particularly encouraged by the fact that increasing numbers of nontraditional students are electing to go on in mathematics. Anecdotal reports from students suggest that they are finding the revised curriculum and methodology more useful and more engaging. Many say they've enjoyed math for the first time. Finally, a limited sampling of those students who go on to take more math and science indicates they are doing well, even in more traditional settings.

[For additional information about Seattle Central's math curricula, contact Jan Ray at 206-587-4080.]

"We also began to see that studying fewer topics in greater depth can produce more profound intellectual development, and that studying ideas in context promotes greater subject coherence."

"Lectures still have a place in our teaching, but are no longer the primary means of promoting learning."



Seattle Central Community College students Huy Tran, Yongsuk Cho and Navid Deiseh tackle a problem together.
(Photo: Bob Hereford)

Seattle Central is a Regional Lab for Interactive Mathematics Text

by Mike Pepe

"Typically groups of two to four students work collaboratively on open-ended discovery projects which require them to use both traditional mathematical skills and the full power of the most sophisticated mathematical software currently available."

A promising new strand in computer software for mathematics education is the development of "interactive texts." These complex problem-solving and learning strategies on the computer involve students as active learners. Under the auspices of the Mathematical Association of America (MAA), six Interactive Mathematics Text Project (IMTP) laboratories were established around the country this past year. IBM is funding the project with a $2.4 million grant, with additional support from the National Science Foundation. Seattle Central Community College is one of the six sites, and was chosen in part because of its prominence within the Washington Center Calculus Project.

Each of the six interactive text sites will serve as training laboratories in the use of computers for development of interactive texts for mathematics students. Workshops for faculty from around the country will be held at various times throughout the year at all six sites. I direct the interactive text lab at Seattle Central. The lab will focus on the use of the powerful mathematics software packages *MathCAD for Windows, Maple,* and *Mathematica.* The developers of *Derive* and *Gyrographics* software have also donated site licenses to the lab to further aims of the project. Professor David Smith of Duke University as been assigned by the national IMTP advisory board to be a special advisor to the Seattle Central IMTP.

This past summer we hosted two six-day faculty workshops at Seattle Central with participants coming from Oregon, Idaho, Montana, California and British Columbia as well as Washington. The subject of the workshops was how to write effective interactive projects using the Windows-based version of *MathCAD* and *Maple*. This was a mixed group of mathematics educators from high schools, community colleges, and four-year colleges and universities. This initial group of participants will form the nucleus of our efforts to form a local coalition of mathematics faculty members at all levels interested in the further integration of computer technology into the mathematics curriculum.

At Seattle Central, because of our long interest in collaborative learning strategies, we are pursuing these ideas in our own classes in a context which emphasizes group problem solving. Typically groups of two to four students work collaboratively on open-ended discovery projects which require them to use both traditional mathematical skills and the full power of the most sophisticated mathematical software currently available. These students meet for class each day in the IMTP lab where each group table of four students has available two IBM 486 computers.

In the coming year MAA will be sponsoring mini-courses on computers and mathematics in the SCCC lab. We are also planning to organize a workshop which would bring together faculty teams from mathematics, physics and chemistry to develop interactive computer projects that feature applications of mathematics to these sciences.

The dates for next summer's interactive text workshops will be:

Mathematica: A workshop by Horacio Porta from the University of Illinois. June 21-28, 1993.

MathCAD for Windows: A workshop by Jim Swift of the Academic Institute of Technology. July 12-17, 1993.

Each workshop will be limited to 15 participants.

[For more information on the IMTP at SCCC contact: Mike Pepe, IMTP Project Manager, Mathematics Department, Seattle Central Community College, 1701 Broadway, Seattle, WA 98122. Phone: 206-587-4073. email: mpepe@u.washington.edu.]

Seattle Central Community College mathematics instructor Mike Pepe working with student Elisa Hoelscher. (Photo: Bob Hereford)

Carl Swenson is professor of mathematics at Seattle University. (Photo: Jean MacGregor)

Will Technology Cripple Our Ability to Do Mathematics?

by Carl Swenson

Imagine the English teachers of America discussing whether children should be taught to read, and if so, in what manner. Such a discussion would touch the heart of our philosophic assumptions about what's worth learning as well as the pedagogical methods we would employ. An analogous discussion about the fundamental philosophic assumptions of the content of mathematics is bubbling up within the mathematics community nationwide. The traditional skills of pencil-and-paper arithmetic upon which much of the elementary school mathematics curriculum is based have come under considerable criticism. Whether or not we should be teaching rote, mechanical manipulations is being called into question. One mathematician has quipped, "The subject matter is from the Middle Ages, the notation is from the eighteenth century, and the pedagogy is from the early twentieth century."

Critics of current content and teaching practices point to the fact that most students are unable to use mathematics or quantitative reasoning in any substantive manner upon entry into the job market. While there are a number of issues important to why our students aren't learning to use mathematics, this article will focus on only one of them: the fact that technology is challenging our cherished notions of what mathematics is, and how it should be taught.

"One mathematician has quipped, 'the subject matter is from the Middle Ages, the notation is from the eighteenth century, and the pedagogy is from the early twentieth century.'"

Calculators

New graphing calculators (available from about $80 upward) have capabilities far beyond the early pocket calculators which many of us use to balance our checkbooks. The newer calculators are able to do arithmetic, statistical and matrix calculations. They can solve algebraic equations, they can draw graphs and create visual displays, and they can be programmed to do special, and often quite involved, tasks. The less expensive of these calculators (less than $100) will solve equations by giving numeric solutions, while more expensive ones (typically about $250) will solve equations both in algebraic symbols as well as numerically. Some of these calculators can be connected to personal computers via direct cables, or in some cases phone line links, and data and programs can be exchanged between calculator and computer. Test models of calculators that link to cellular phone networks are being used currently, and may be commercially available in the very near future. We may all soon have access to calculators that can connect to and communicate with computers at remote office sites or at our homes.

...And Computers

Coupled with this razzle-dazzle hardware technology is computer software capable of performing virtually all of the symbol manipulations that we have traditionally taught in the first fourteen years of school. This includes the ability to do a significant amount of the symbol manipulation central to calculus classes for the past two centuries—the computing of derivatives or integrals of closed analytic functions. Computer software (going by the trade names of *Derive, MathCAD, Mathematica, Maple,* or *Theorist*) will do everything graphing calculators will do, and much more. Full color displays of multi-dimensional objects, often rotating to better illustrate their surface features, are becoming commonplace; and inexpensive, user-friendly mathematics software will soon be available in virtually every office in the country that has any need to use mathematics.

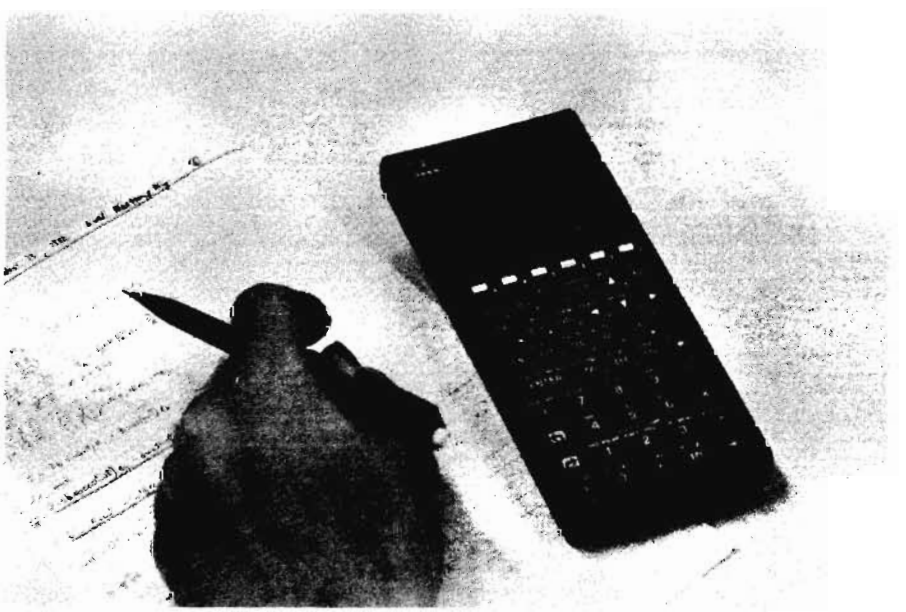
Anyone with access to a graphing calculator or computer software can now push a few buttons to do algebraic manipulations, solve equations, graph functions, compute derivatives or integrals, or invert matrices. So, should we continue to teach students to do all this by hand? Or, if not, then what *should* we be teaching? The mathematics community is still divided on these questions. While some argue vehemently for traditional training, others such as Lynn Steen (whose article appears in this issue) see this as simply bogging down students, "digging and filling intellectual trenches." In *Calculus for a New Century*, Thomas Tucker put it even more strongly, "What happens when our calculus clients find we are still teaching the moral equivalent of long division while they simply want their students to know how to push buttons intelligently?"

Washington's Response

Most colleges and universities in Washington state are responding by integrating technology into mathematics teaching. While not yet in every course, or in every lesson, technology is nevertheless being used increasingly by instructors for in-class demonstrations, and by students for in-class work sessions and on exams and homework.

Like science courses, many mathematics courses now schedule labs. For example, at Seattle University, a graphing calculator is required for our precalculus course and a weekly computer lab is required for the beginning calculus course. These two courses are specifically mentioned because they have received national attention. Seattle Central Community College and The Evergreen State College have been using computers or graphing calculators in the classroom for several years. A Multivariable Calculus Computer Lab Project using *Theorist* and a course entitled Linear Algebra, Geometry, and *Mathematica* are under way at the University of Washington. Calculus laboratory projects have been published by Washington State University. Many colleges in the state are using either the Harvard Consortium calculus materials, or the Duke University Project CALC materials, both of which rely on the use of laboratory exercises.

Much of the focus of the Washington Center's calculus dissemination project as well as The Precalculus Revitalization Project sponsored by Seattle University and Seattle Central Community College is to foster fruitful use of technology in the classroom. In addition a Washington Center Seed Grant on Visualization in Multivariable Calculus was awarded to Eastern Washington University last year. The Interactive Text Project, a national project sponsored by the Mathematical Association of America and IBM and housed at Seattle Central Community College, is developing materials for interactive texts in mathematics (see Mike Pepe's article in this issue). Graphing calculators are also working their way into high school curricula, and in 1995 the Advanced Placement Calculus Exam (administered by the College Board) will permit the use of graphing calculators for the first time.



"The new graphing calculators can solve algebraic equations, draw graphs and create visual displays, and they can be programmed to do special, and often quite involved, tasks." (Photo: Jean MacGregor)

Are We Crippling Student Abilities?

Will all this readily available technology cripple students' ability to manipulate symbols? Yes, and no. Students will become dependent upon calculators and computers for routine algebraic manipulation, and they may lack an understanding of the underlying steps. This is somewhat analogous to how most of us use automobiles: we are quite dependent upon our cars, but few of us understand the inner workings of the machine.

However, students, freed from the routine drudgery, now have time to think about mathematics in ways they never could have before. In the past, they laboriously plotted points as the means to graph a function that they now can graph in seconds by pushing a few buttons. The calculator/computer frees students to ask a whole array of questions heretofore inaccessible. In my own classes I have found that the efficiency available through the calculator leads students to explore many more functions than previously possible, and out of this experimentation and more extended conversation, a deeper understanding of the nature of functions arises.

This is also where mathematics meets the real world. Rather than focusing on the manipulation of abstract symbols, we now are able to focus our energies on translating many important questions into mathematical form: creating a mathematical model. Technology allows us to explore more readily the consequences of differing assumptions on the output of our mathematical model. At this point we generally see *real* student engagement. Students discuss, even argue, the concepts underlying the model, the effects of differing assumptions, or the "reasonableness" of the solutions the model is giving them. They find themselves in the position of having to make *judgments* about data, rather than trying to produce "right answers" similar to those in the back of a book. Interpreting what the mathematical model is saying about the real world, having to make judgments based upon assumptions underlying a model, become the focus of the learning in my classes.

Today's technology is indeed liberating students from having to "dig and fill intellectual trenches." Thomas Tucker again, "We may even end up in the future not only with 'machines that think' but also with 'students who think.'" The graphing calculator and the personal computer are having a powerful and positive effect on teaching and learning mathematics. They are challenging us to rethink not only the mathematics classroom, but the nature of mathematics itself.

"Students, freed from the routine drudgery, now have time to think about mathematics in ways they never could have before."

Duke University mathematician Lang Moore introducing a Duke Project CALC problem to Western Washington University faculty members Tjalling Ypma and Keith Craswell. (Photo: Robert Cole)

Learning Community Programs in Washington–Winter 1993

Learning communities purposefully restructure the curriculum to link together courses so that students find greater coherence in the courses they take, as well as increased intellectual interaction with faculty and fellow students. The following is a listing of learning communities under way in winter 1993.

Unless otherwise indicated, the learning communities at the community colleges are being offered in college transfer "A.A." degree programs. Please be in touch with the colleges and faculty involved if you would like more information about any of these programs.

Bellevue Community College		
Coordinated Study	"Speaking of Environment"	Pat Alley/American studies Lee Buxton/speech Betty Lyons/geology
Team-taught Linked Class	"Alternate Realities: Deviant Personality & Introduction to Literature"	Joan Kotker/English Helen Taylor/psychology
Centralia College—East County Center		
Linked Class	"The Family: Composing Relationships"	Mark Bratlie/sociology Michelle Birley/English
Clark College		
Linked class	Developmental/English as a Second Language "Psychology and Study Skills"	Priscilla Martins-Reed/ESL Kathy Bobula/psychology
Columbia Basin College		
Cluster	"Time and Rhythm"	Bill McKay/music Meg Woods/U.S. history Bob Pedersen/English
Cluster	"Comparative Organizations: Competitiveness in the World Economy"	Craig Mason/sociology Sully Bayless/business Teresa Thonney/English
Edmonds Community College		
Coordinated Study	"Re-Enchanting the World: Ecology, Mythology and Literature"	Charles Mish/humanities Holly Hughes/English
Coordinated Study	"Counterpoint: Music and Society"	Anne Martin/sociology Rick Asher/music
Coordinated Study	"Renaissance and Revolution in Word and Deed"	Eileen Soldwedel/history Bruce Reid/English
Everett Community College		
Cluster	Cluster for Returning Women Students	Kristi Francis/English Dick Brigham/sociology Sharon Wellman/mathematics
Gonzaga University		
Linked Class	"Ethics and Fiction"	Rose Mary Volbrecht/philosophy Mary Jo Bona/English
Highline Community College		
Linked Class	"Writing About Current Political Issues"	Davidson Dodd/political science Michael Smith/writing

Lower Columbia College

Team-taught Linked Class	"Exploring the Self"	Michael Strayer/psychology Carolyn Norred/English Jerry Zimmerman/humanities

North Seattle Community College

Coordinated Study	"Pacific Northwest: History, Culture and Landscape"	Neil Clough/history & political science Gail Baker/environmental science John Constantine/art Edith Wollin/English
Coordinated Study	"Destiny, Darwin & DNA"	Larry Hall/psychology Mike Kischner/English Denise Lim/biology Susan Starbuck/history
Coordinated Study	"Conflict and Conformity in Society and Culture: A Comparative Look at Africa and Japan"	Setsuko Tsutsumi/Japanese literature Ben Abe/anthropology
Coordinated Study	"Beginnings: An Introduction to Diverse Peoples, Cultures, and Values"	Angela Djao/Asian studies Harris Haertel/geography Jim Harnish/history Bruce Kochis/cultural studies
Coordinated Study	"The World of Work in America" Bruce Kochis/history &cultural studies	John Masen/business and economics

Pierce College

Developmental Team-taught Coordinated Study	"Patterns"	Diane Downie/mathematics Linda Streever/English

Seattle Central Community College

Coordinated Study	"Taking Sides on the Environment—Profits or Paradise?	Al Hikida/English Hal Pelton/mathematics Jim Hubert/economics
Coordinated Study	"Reflections of Time: The Inquiring Mind"	Cynthia Imanaka/sociology Tracy Lai/history Carl Livingston/political science Carl Waluconis/English
Coordinated Study for Developmental Students	"The Joy of Math and English"	Bobbi Righi/mathematics Valerie Bystrom/English
Coordinated Study	"Myth and Reality"	Astrida Onat/anthropology Paula Bennett/English John Fox/philosophy

Shoreline Community College

Team-taught Linked Class	"Food for Thought"	Venus Deming/nutrition Pam Dusenberry/developmental English
Team-taught Linked Class	"The Zoo is You"	Don McVay/biology Alex Maxwell/English
Team-taught Linked Class	"The Giant Next Door: Canadian History and Literature"	Lloyd Keith/history, sociology Amy Mates/English
Team-taught Linked Class	"Civilization and Culture in the Era of Revolutions"	Dennis Peters/English Wayne McGuire/English Kathie Hunt/English

Skagit Valley College

Coordinated Study	"The Search for Self"	Trish Barney/humanities Linda Moore/developmental ed. Mike Witmer/psychology
Linked Class	"Biology: Applications and Implications"	Skip Pass/biology Jill Fugate/humanities
Coordinated Study	"Cinema and Sexuality"	Lynn Dunlap/humanities Lynne Fouquette/psychology

Skagit Valley College—Whidbey Campus

Coordinated Study	"Hearing Voices: Sanity, Creativity and Human Expression"	Barbara Moburg/psychology Les Stanwood/drama and literature

South Puget Sound Community College

Cluster	"The Garden in American Thought & Experience"	Michael Shurgot/literature Lois Fenske/economics Rod Rakowicz/biology
Linked Class	English and Geology	Don Johnson/literature Jim Strong/chemistry
Developmental Linked Class	Reading and Writing	Kay Cooper/developmental ed. Nancy Elliot/developmental ed.
Developmental Linked Class	Reading and Study Skills	Nikki Raudebaugh/developmental ed. Kalim LeBlanc/counseling
Linked Class	English and Philosophy	Phyllis Villeneuve/humanities

Spokane Community College

Cluster	"In Stone and Song"	Virginia VanCamp/art Shusmita Sen/English Susan Herdrich/literature
Team-taught Linked Class	"Adrift Alone in the Cosmos"	Jim Roth/literature Lynn West/English
Team-taught Linked Class	"Media and Messages"	Carolyn Wall/English Debbie Kyle/journalism

Spokane Falls Community College

Team-taught Linked Class	"Issues in Mass Media"	Klaus Scherler/journalism Jim Barrett/communications
Linked class	"Genre in Literature and English Composition"	Rose Matis/communications
Team-taught Linked Class	"American Literature and Advanced Composition: a Study in Pairs"	Steve Reames/communications Ed Reynolds/communications
Developmental Linked Class	Elementary Algebra and Study Skills	Larry Neises/mathematics Jani Mahony/study skills
Linked Class	Introduction to Literature and Creative Writing	Tom Versteeg/communications Almut McAuley/communications
Coordinated Study	"Leonardo to Voltaire: A Renaissance of Ideas and Images"	Robert Ferrar/history Carolyn Stephens/art history Nel Hellenberg/communications Barb Fulsaas/library research
Coordinated Study	"Japanese Culture: Pasts and Present in Conflict"	Tom McLuen/history Fran Brewer/communications

Tacoma Community College

Coordinated Study	"Making Connections"	Marlene Bosanko/English and humanities Tamara Kuzmenkov/English and humanities
Coordinated Study	"Family Portraits"	Violetta Clee/English Gwen Overland/drama and music
Developmental Coordinated Study	"Math Anxiety"	Karen Clark/mathematics Diane Nason/counseling
Developmental Coordinated Study	"Focus on Success"	Suzanne Butschun/mathematics Sonnia Dailey/data processing

Walla Walla Community College

Team-taught Linked Class	Basic Math and Reading	Ann Bogard/developmental ed. Elen Montoya/developmental ed.

Western Washington University—Fairhaven College

Linked Class	"Discovery"	David Mason/science Toni Hinsley/art and Native American studies

Yakima Valley Community College

Developmental Team-taught Linked Class	"Mind Over Math: Math Anxiety in Pre-Algebra"	Carolyn Gregory/mathematics Kathy Calvert/counseling
Team-taught Linked Class	"We're All in This Together: Understanding Ecology Through Speech"	Eric Mould/biology Millie Stenehjem/speech
Team-taught Linked Class	"American History Live: Characters and Events Which Shape Today's America"	Jim Newbill/history Chuck Weedin/speech
Team-taught Linked Class	"Be One with the Great Writers: Shakespeare, Moliere, Seneca, and You"	Inga Wiehl/English George Meshke/drama
Linked Class	"Writing South of the Border: English Composition and Latin American Fiction"	Denny Konshak/English

Other learning community programs in Washington:

The Evergreen State College's curriculum is largely organized around 16-credit, team-taught coordinated studies programs. About 30 coordinated studies programs are offered each quarter, each one addressing interdisciplinary themes or questions. For information on this year's programs, write The Washington Center for a current catalogue.

Washington Center Workshops & Conferences 1992-93

"Hearing Many Voices, Learning as One: A Conference on Collaborative Learning." Keynote presenters include Parker Palmer and Lee Knefelkamp. February 19-20, 1993. Sheraton Seattle, Seattle.

Spring Curriculum Planning Retreats at Two Sites

- April 28-29 in Eastern Washington at the Bozarth Center of Gonzaga University in Spokane.

- May 13-14 in Western Washington at the University of Washington's Pack Forest near Eatonville.

Other Conferences of Interest

American Association for Higher Education. Washington, D.C. "Reinventing the Community: Moving Ahead Despite Tough Times" March 14-17, 1993. For further information, call AAHE at 202-293-6440.

Washington Community and Technical College Humanities Association. April 29-May 1, 1993, in Olympia. The conference whose theme is "Multiculturalism," will be keynoted by Charles Johnson, author of *Middle Passage*. For further information, call Jerry Zimmerman, 206-577-3450, or Terry Mirande, 509-762-5351.

Fourth Annual State of Washington Higher Education Assessment Conference. The theme is "Making a Difference in Undergraduate Education." May 6-7, Tyee Hotel, Olympia. For information, call 206-586-8296.

Sixth Annual National Conference on Race and Ethnicity in American Higher Education. June 3-8, 1993. For information, call The Southwest Center for Human Relations Studies, 405-325-3936.

American Association of Higher Education Annual Assessment Conference: June 9-12, 1993. Palmer House Hilton, Chicago. For further information, call AAHE at 202-293-6440.

What's Happening in Undergraduate Education in Washington State

Interests Groups Expand at University of Washington

The **University of Washington** offered 42 Freshman Interest Group programs this fall to 870 entering students—a new high. Groups of 20-25 students registered for three classes linked around a common theme (e.g. "The Individual and Society," "The Global Environment"), or for preparatory course work for a major (.e.g., engineering, health sciences, or architecture). In addition, each "FIG" met once a week in a proseminar with a peer advisor. Each group also had, for the first time, a "faculty preceptor," a member of the UW faculty who volunteered to meet informally with the FIG to introduce students to the University and to their own work. FIG peer advisors nominated these preceptors.

Transfer and Returning Student Interest Groups ("TRIG's") are also becoming more popular at UW, with the Sociology, Psychology, Political Science, English and Biology Departments offering or exploring their use as a method for easing the transition to the University for transfer students. In each TRIG, a cohort of students registers for two or three junior level courses in the department, and meets in a proseminar with a teaching assistant. [For additional information, call Ken Tokuno, 206-543-5340.]

Learning Community Approaches Develop in ESL

The English as a Second Language faculty at both **Shoreline** and **Seattle Central Community Colleges** have been building learning community approaches into their ESL curricula, by organizing course offerings into larger blocks of time and credit to integrate instruction in communication skills, and by focusing the course content on interdisciplinary themes.

At Shoreline, the beginning level 10-credit programs will take survival as their theme; multicultural issues will be featured at the intermediate level, and social science or humanities themes will be taught at the advanced levels. Seattle Central is also teaching in 10-credit blocks. The beginning level students can add a 3-credit introductory computer science class, and the more advanced students can elect a 3-credit library research class.

...and in High School Completion Programs

We've been hearing about new high school completion learning communities at both **Everett** and **Edmonds Community Colleges**. Ken White sent us this report about the Everett initiative:

Since 1980, the Everett Community College Adult High School Diploma program has offered specially designed classes to help students meet the Washington State requirements for a high school diploma. This fall, the day-time program was revamped to become the Interdisciplinary Adult High School Completion program. While the program continues to offer students a wide range of subjects, including U.S. History, English, Contemporary World Problems, General Science, and Pacific Northwest History, a learning community approach now unites various classes and brings greater focus to the learning experience. Each class is assigned one to four major clusters organized around a central theme or idea. Next quarter, two clusters of English, social science, and general science classes will address the topics of "Darwin and Dinosaurs," and "Computers, Spies and Private Lives." Two other clusters will look at "The Civil War," and "Making Sense of the Sixties." In addition, course hours have been changed from the traditional fifty-minute periods to two-hour blocks, allowing more time for student seminars, active learning, and the building of connections among disciplines and ideas. Writing across the curriculum and student portfolios are also key features of the program. [For further information, call Ken White at 206-388-9498.]

Washington State University Pilots Model Freshman Learning Community

Residence Life and the academic programs at **WSU** collaborated this fall to create three small learning communities of students. In this model, three groups of about 20 students living in the same residence hall were all enrolled in one common class. The faculty and classes were Helen Place (Chemistry 105), Larry Davis (Geology 101), and Richard Law (World Civilizations I). Each faculty member met informally with their student cohort several times during the quarter—to build study groups or simply to get to know the students better. The spearhead for this initiative is Jane Parker, coordinator of peer advising in the student advising and learning center. It's just one of a number of freshmen year initiatives known as PAWS ("Pride in Achieving Wazzu Success") designed to help the transitional needs of new freshmen. Next semester, one of the resident hall cohorts will be enrolled in two courses, English 101 and the World Civilizations course. [For further information, contact Jane Parker, 509-335-4357.]

Western Washington University's "Law and Diversity" Learning Community Moves into its Second Year

Fairhaven College at **Western** is well into the second year of a unique upper division learning community, "Law and Diversity." This is a two-year upper division curriculum for students interested in an interdisciplinary preparation for graduate work in law. "Law and Diversity," a modified federated learning community model, enrolls a cohort of students who take three classes, and meet weekly for an integrative seminar with Fairhaven faculty members Rand Jack or Loraine Bannai.

The 15 students who entered the program last year had completed their general university requirements and chose this program as their major. Several students transferred into Fairhaven to participate in the program. As the program planners hoped, a diverse group of students enrolled: 3 are Hispanic, 5 are African American, 3 are Native American and 4 are Caucasian—about evenly split between male and female students. "100% of last year's students returned for their senior year in the program," reports Marie Eaton, Fairhaven's Dean. "The students are showing remarkable gain scores in their LSAT's, and all of them are succeeding in the program. We are thrilled." [For further information about the "Law and Diversity Program," contact Rand Jack, 206-650-4906.]

Pacific Lutheran University Opens New Center for Teaching and Learning

This fall, **Pacific Lutheran University** opened a Center for Teaching and Learning, sponsored by the Office of the Provost. Dwight Oberholtzer, professor of Sociology, is the first director, complemented by a seven-person faculty and academic staff Board with student consultants. The Center is building upon programs initiated and sustained by the Task Force on Teaching and Learning, established at the college in 1979. Dwight reports, "The faculty originated the Task Force, and the CTL continues to have a distinctive grass-roots, faculty-driven flavor, even though the Provost's Office is its institutional home and budgetary patron."

Grants from the Aid Association for Lutherans and from the Florence B. Kilworth Charitable Foundation help sustain the Center's activities. The Provost's Office coordinates a separate mini-grant program for teaching experiments. The centerpiece of the PLU program has been an annual June conference on teaching, led in June 1992 by Parker Palmer and Lee Knefelkamp. During the school year, the conference's inspiration was sustained with faculty-led luncheon conversations focusing upon instructional issues and literature, a quarterly routing by library staff of recent articles from major teaching journals, a periodic newsletter, and special resources for new and recent faculty. In addition, faculty clusters have emerged around specific topics such as learning styles, gender, multicultural experience and course materials, the case study method, and, most recently, grant writing, student classroom observation, and the linking of student scholarship and service.

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The Washington Center for Improving the Quality of Undergraduate Education

■ Established in 1985 at Evergreen as an inter-institutional consortium, the Center focuses on low-cost, high-yield approaches to educational reform, emphasizing better utilization and sharing of existing resources through inter-institutional collaboration. Established with funding from the Exxon and Ford Foundations, the Center is now supported by the Washington State Legislature.

■ Includes 43 participating institutions: all of the state's public four-year institutions and community colleges, and nine independent colleges.

■ Supports and coordinates inter-institutional faculty exchanges, the development of interdisciplinary "learning community" programs, conferences, seminars and technical assistance on effective approaches to teaching and learning.

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