

Washington Center

NEWS

WINTER/SPRING 1996

Volume Ten
Number One

Changing Teaching; Changing Teachers; The Impact of Calculus Reform

by Robert S. Cole

In five years, we have seen our Washington Center Calculus Reform Dissemination Project have a tremendous impact on mathematics teaching and mathematics teachers. Reformers at forty-three campuses in the Pacific Northwest, (listed on page 15) have enthusiastically embraced new calculus content and new teaching methods. Many of us have developed new materials of our own or borrowed heavily from those that have. Others of us have experimented with new classroom strategies and new ways of fostering active and collaborative learning among students. We have taught ourselves (often just a step or two ahead of the students!) the intricacies of graphing calculators or new mathematics computer software. We have wrestled

with new subject matter as we learned to teach applications problems in calculus based in psychology, biology, physics, engineering or economics. Our students have, for the most part, been enthused by this new approach to mathematics. Many have seen mathematics come alive for them for the first time. Traditionally under-represented groups have found the new classroom dynamics of many reform courses unexpectedly welcoming.

However, the results of calculus reform have been by no means uniform, either within the state, regionally or nationally. Not all our mathematics colleagues believe in the goals and approaches of the calculus reform. Many departments are divided over issues of textbook adoption or the content of the

calculus sequence. Calculus reformers occasionally feel isolated within their own departments. Others are examining their sense of themselves as teachers as they struggle to move from a lecture-based classroom to one involving active or collaborative learning. Even the most confident of reformers has at times felt exhausted by having to constantly master new teaching methods and new dynamics with students. Calculus reform demands learning new content. Further, it has often means experimenting with new teaching methods unlike anything we ever experienced in our own college careers.

Yet despite these challenges, calculus reform appears to have had an irrevers-

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, Northwest Indian College, Olympic College, Pacific Lutheran University, Peninsula College, Pierce College, Renton Technical 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, Whitworth College, Yakima Valley Community College.



Robert Cole at last summer's Reform Calculus workshop at The Evergreen State College. (Photo: Jean MacGregor)

“Substantive curriculum reform must confront thorny issues of human interactions within both the classroom and the department.”

ible effect on calculus courses, and the effects of reform appear to be spreading to courses that occur both prior to and subsequent to the calculus sequence. Whether all mathematics faculty members agree with the tenants of calculus reform or not, pieces of reform are appearing in “traditional” texts. Technology (the term mathematicians use for graphing calculators and computer software) is having an unmistakable impact on course content. Disciplinary applications of mathematics are sprouting in all kinds of math courses. Collaborative learning methods are spreading rapidly, both in K-12 and in college math courses.

What we *have* learned in the five years of this project is that curricular reform is not as simple as any of us might have first imagined. Most mathematics courses have traditionally been closely tied to a textbook. Many of us thought at first that simply adopting new texts would bring about course reform. We've learned, sometimes painfully, that a revised textbook does not a reform movement make. Texts don't readily address issues of how best

to teach the use of technology to our students. Texts are largely silent on issues of active and collaborative learning strategies (and even if they weren't, *reading* a book is not the way to learn to successfully manage small-group work in the classroom!). Texts have no advice on building collegial support, and they don't help create communities of *faculty* learners. Texts offer little guidance for assessing student writing or oral presentations or student project work. In the words of one of our colleagues when discussing what to pay attention to in reform efforts: “It's not the textbooks, stupid, it's the teachers!”

Our project has paid close attention to teachers. We've maintained our momentum because of the strong sense of community we've built among faculty interested in curricular reform. This sense of community has enabled us to probe uncharted territory and discover new ways to assess student learning, new structures of collaboration in the classroom and new content fostered by the existence of technology. The leadership of the Washington Center has aided us immeasurably in this effort, and we find that after five years there is a solid network of mathematics reformers in our region. This group has agreed to continue our work together after National Science Foundation funding of our project ends this summer.

One component of community-building has been sharing promising approaches on a regular basis. Many workshop participants told us how important they found the opportunity to talk with one another about what was working and what wasn't. The results of some of our best collective work was organized and compiled in *The Washington Center Source Book for Revitalized Calculus*, published last July.

New approaches to assessment are an essential ingredient of sustainable curricular reform. Some of what I believe to be the most innovative approaches to tricky and difficult assessment issues in calculus were published in our book *Assessment in Reform Calculus* last July. As with our *Source Book*, it represents work-in-progress in new territory. Revisions will be obvious as we all learn more and gain further experience.

Finally, substantive curriculum reform must confront thorny issues of human interactions within both the classroom and the department. Several workshops dealt with collaborative learning and ways we could build our competence and confidence at facilitating small-group work. Our February '96 meeting addressed a variety of departmental issues associated with calculus reform. Our conversations revealed that calculus reform is sometimes one straw too many on the back of departments already burdened by complicated dynamics with years of history. Curricular reform often triggers debate that has little to do with the immediate issues of reform. The dynamics of collaborative decision-making (an area in which few of us have training) is one of the most essential elements of curricular reform of any stripe, yet we often embark on curricular reform as if it were just a matter of course content.

But don't take it from me. Read what our colleagues have to say.

Eric Schulz makes clear the effects technology has on the *content* of mathematics courses. Diane Downie writes about the recent retreat for our reform calculus network, and what it has meant to her and her departmental colleagues. Bobby Righi summarizes what she learned from interviewing students regarding small-group work in mathematics. Janet Ray, co-director of the Washington Center Calculus Dissemination Project, lists materials that reflect the impact of calculus reform on courses taught prior to calculus. I've written about the impact of calculus reform on courses taught subsequent to calculus. And Phyllis Leonard offers a very personal reflection about the impact of calculus reform on her emerging sense of the spiritual dimensions of teaching.

Happy reading.

Robert S. Cole is a co-director of the Washington Center Reform Calculus Dissemination Project (1991 - 1996), and a member of the faculty of The Evergreen State College in Olympia, Washington.



Jeanine Elliott, the Washington Center's new director. (Photo: Steve Davis)

The Washington Center's Second Decade

A note to my colleagues in the Washington Center from Jeanine Elliott

The Washington Center for Improving the Quality of Undergraduate Education came into existence in the mid-1980s, at a pivotal time in the history of postsecondary teaching and learning in this country. While nationally there were calls for educational improvement and reform, in Washington State, colleges and universities, faculty and administrators, were implementing and assessing a host of strategies designed to make it possible for increasing numbers of students coming from increasingly more diverse backgrounds and academic preparations to gain what they and their society needed from higher education. Issues of the *Washington Center NEWS* chronicle these educational innovations. Learning communities, collaborative learning, cultural pluralism, interdisciplinary teaching, reform calculus, academic success of students of color, assessment and evaluation, introductory science curricula, writing across the curriculum, student cognitive development, ways of knowing—as these have been explored and implemented in a variety of ways across the state, the teaching and learning experience of faculty has been expanded and enriched.

As the new director of the Center, I have been asked, “What’s next for the Center?” And while there is a “next” (see related article on *collaborative learning and interactive technology*), I want to focus here not on what *more* we are going to do, but what we need to do to *sustain* the work that has been so effectively developed within the state.

Arthur Levine, writing in a recent issue of *Change* magazine, says that we appear to be reaching the end of the current era of educational reform. He notes that earlier generations of reform dribbled away and have had to be recreated in later generations. Certainly the history of learning communities reflects this cycle of birth and rebirth. From my own earlier experience with women’s education in this country, a hundred years of “innovation” reveals a cycle of risk-taking and caution that continues into our own era. Levine asks us, “What can and should be done over the next five years to bring this period of reform to a successful conclusion?” He speaks from the perspective of the “big picture,” as a scholar of large systemic change; at the

end of five years, he would like some tangible evidence that this round of educational reform has made a difference and that we don’t have to “start over again” when the next call for reform comes.

The faculty and administrators who are part of the Center’s network are the practitioners and scholars of small-system change. Our systems change in one course or program, or in one process of curriculum revision, or in one round of difficult and healthy conversations about cultural diversity. One small change follows another; over time, if we can sustain our efforts, we see differences in our students, our institutions and ourselves. We see signs that our small systems are becoming communities where individuals and groups are learning from and with each other and that this learning is contributing to the development of healthy, productive, diverse communities in the larger society. Our questions, then, are, “What must we do to make sure that what we have learned becomes integral to our programs, our institutions and our own professional lives?” And, “What must we do so that in five years, or 10 years, we do not have to start over again?”

For many of us who have been involved with various educational reform movements and strategies, innovation is not “hard.” It is exciting, challenging, anxiety-producing and often frustrating, but it is not hard. What is hard is *sustaining change*—being in for the long haul, wading through administrative details, changing policies and structures, quibbling over subtleties with colleagues, becoming conservators of the tradition while remaining open to new ways of working, remembering our histories, bringing new people into an ongoing process, cleaning up our messes. The hard work of our small-system change is in front of us. I am looking forward to sharing in this work with you during the second decade of the Washington Center.

Jeanine Elliott



Diane Downie. (Photo: Jean MacGregor)

An Island In Time: A Report on the Calculus Consortium Retreat held at Rainbow Lodge February, 1996

by Diane Downie

“A serious challenge is the struggle to find a large enough framework to contain departmental differences so that departments are not immobilized by dissent.”

My involvement with the Washington Center Calculus Consortium began with my participation, with two other instructors from Pierce College, in an introductory eight-day workshop in the summer of 1992 at The Evergreen State College. We were introduced to the calculus reform curricula developed by the Harvard Consortium and Duke University. We quickly decided the Harvard curriculum was better suited to our situation and would be easier to implement at our college. Equally important, we were excited by the suggested pedagogical approaches that emphasized actively involving students in the learning process. This intense workshop was thorough enough for us to be willing to try this new approach. Little did we know what we would unleash for our department, our students and ourselves.

Over the next few years we implemented the reform calculus curriculum and pedagogy at Pierce and, in the process, we began to examine the curricula and format of all our other courses. The genie was out of the bottle. We had seen how much more effective and exciting it was to engage students in examining “real world” problems, to view calculus concepts from multiple perspectives, to use graphing calculators and to have students involved in projects and writing assignments. We wanted this relevance and intensity in all our courses. This examination of our courses has led to intense discussions in our department and we are by no means at the end of this process. Our momentum would not have been sustained except for the retreats for calculus folks we were able to attend twice each year and the “on call” advice and support for the project directors, Janet Ray and Rob Cole.

The most recent retreat at Rainbow Lodge for people involved in the Washington Center Calculus Consortium gave us an opportunity to carve out a little island of time away from our day-to-day routine and the demands of our teaching schedules. We were able to reflect on what we are doing with respect to calculus reform, why we are doing it and what steps we might want to take next. Most importantly, we spent a significant amount of time reflecting and working with one another.

Once again I found myself energized and enlivened by the interaction with colleagues involved with calculus reform. This retreat culminated years of working together to rethink and revise our calculus curriculum at each of our campuses. Over the years we have become a support group for one another. We’ve been able to make changes to our courses and then, during the retreats, come back to our colleagues for further conversation to help us sort out what is working and what isn’t and to get ideas for new approaches. Each time we reconvene, new colleagues join us—broadening the conversation. We are a varied group from markedly different institutions with a wide range of experiences, and so we bring very diverse perspectives to our discussions.

We began our time together at Rainbow Lodge focusing on the positive impacts of teaching reform calculus and the tensions or issues that have emerged that need collective attention. Every person in my group reported significant changes both personally and in their teaching as a result of being part of the calculus reform effort.

It has revitalized us and our teaching. Several reported that once they had experienced the vitality of a classroom where students are actively engaged in the learning process, they wanted it in all their classes. One participant phrased it: “We are not waiters dumping stuff at students, but catalysts facilitating learning.” There is an increased concern with how much students are actually learning. Most of us want to shift the way we teach all our courses as well as what we teach. Most of us are still struggling with what that looks like, and feel we need more tools to consistently structure a student-centered classroom. The discussion about active learning reminded me of the analogy of pouring new wine into old skins. Sometimes the old skins crack and break. Putting “new” curriculum into a course taught with traditional methods may not fit. We are challenged to find a new framework within which students can explore the new ideas.

Implementing reform curriculum on our campuses has generated considerable dialogue — sometimes heated — among colleagues in our departments. Substantive issues have been raised and addressed such as: why are we

teaching calculus; what is math; what is the relationship between math and technology; how can we structure our math program so students feel welcome and can be successful; what are connections between math and other disciplines and the workplace; and how lean and how lively do we want our curriculum to be? Raising such issues and stimulating dialogue in our departments on these topics is a welcome impact. Some departments report sharp differences between members. One serious challenge is the struggle to find effective ways to resolve these differences or find a large enough framework to contain these differences so that departments are not immobilized by dissent.

We spent much of this retreat strategizing, problem-solving and planning for the future. Collectively, we realized that the aforementioned genie was out of the bottle on all of our campuses, and we examined issues associated with infusing reform curriculum and pedagogy into the rest of the curriculum. A number of schools have revitalized their precalculus courses and a few reported having implemented changes in their algebra courses. Obstacles to introducing the approaches of reform mathematics into the developmental level courses include the lack (until very recently) of appropriate texts and the fact that part-time faculty teach most sections of these classes. These part-time instructors, under-compensated for their teaching, have little or no time for curricular planning or faculty development experiences as they commute between campuses to piece together a living wage.

A major discussion group focused on concerns about orienting faculty, both full- and part-time, who want to become involved in teaching reform curricula. Several excellent suggestions emerged: (1) Invite part-time instructors to all meetings, workshops, and discussions involving reform curriculum; (2) pair faculty new to the reform approach with one or more faculty that are teaching the same reform course so they can have an ongoing conversation as the term progresses; (3) invite instructors to observe each other's classrooms; (4) model activities (especially collaborative learning techniques) with colleagues;

and (5) share resources of handouts and projects to help save instructors' time.

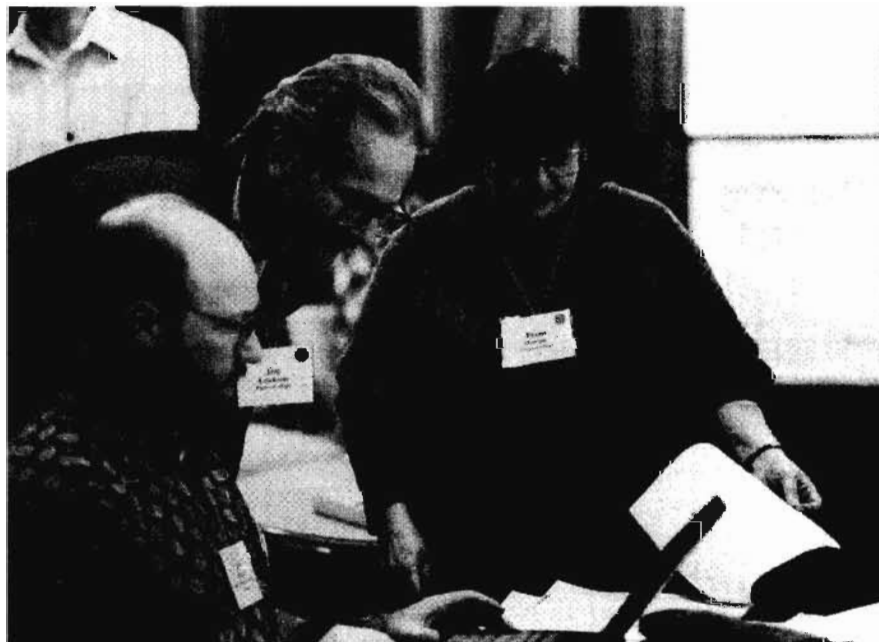
The retreat's discussion and reporting cycles were interspersed with, and enlivened by a poster session for sharing ideas and a panel presentation on cooperative learning strategies.

An important consensus emerged at the end of the retreat: we must keep the momentum going by staying connected through E-mail, snail mail and telephones; we must continue to gather at additional retreats after the largesse of National Science Foundation funding concludes. Perhaps one of the most significant lessons from the past five years is the value of this network and our ability as a group to define, tackle and solve substantive educational issues. The sense of community that has emerged is priceless.

Diane Downie is a faculty member and coordinator of mathematics at Pierce College in Tacoma, Washington.

“We are not waiters dumping stuff at students, but catalysts facilitating learning.”

“The discussion about active learning reminded me of the analogy of pouring new wine into old skins. Sometimes the old skins crack and break.”



At the February Reform Calculus workshop, Eric Schulz (Walla Walla Community College) demonstrates new software wizardry to Jim Erickson and Diane Downie (both of Pierce College). (Photo: Jean MacGregor)



Eric Schulz. (Photo: Jean MacGregor)

Impacts of Technology on the Mathematics Curriculum

by Eric Schulz

“Twenty-five years ago handheld calculators trivialized some of the rote numerical skills we taught. Calculators today are providing us similar opportunities to focus less on rote symbol-manipulation skills and rather on topics more relevant to current times.”

The curriculum content of mathematics courses has been, and will continue to be, impacted by the technological advances of our society. Many math educators can remember when handheld calculators were an interesting novelty. They were not integrated into mathematics courses immediately, perhaps due to the fear that students would learn less mathematics rather than more, but are now standard in almost every math course throughout the curriculum. Using a calculator to calculate the output of a logarithm or square root requires little effort compared with using “old fashioned” tables. In fact, the introduction of handheld calculators twenty-five years ago trivialized many skills that had been firmly entrenched in mathematics curriculums for a couple of centuries.

My father recently asked me to remind him how to find the square root of a number using a pencil-and-paper algorithm. During the discussion that followed I realized that not only after teaching for a decade had I never taught anybody to find the square root of a number using only pencil-and-paper, but that I cannot remember ever performing the algorithm by hand as a student during any portion of my education. Calculating the square root of a number is one example of a skill that was considered important during the years of my father’s education but now is discussed primarily for its historical value. Without a doubt it was the development of the handheld calculator in the 1970s that drove this particular change in the curriculum.

Mathematics educators are continually challenged to evaluate curriculums in light of the day and age in which we and our students live and work. For example, solving cubic equations like $6x^3 - 7x = 5$ has been beyond the traditional paper-and-pencil techniques taught in algebra or precalculus courses. However graphical solutions are readily produced on any graphing calculator. Figure 1 illustrates how an HP-48 displays the root of this equation. Such calculators have enabled instructors to expand the range of equations with which they can expect their students to work. The content of algebra and precalculus courses has changed dramatically in the last eight or nine years simply because of the use of graphing calculators.

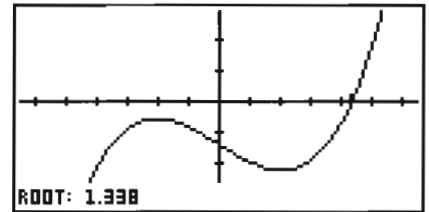


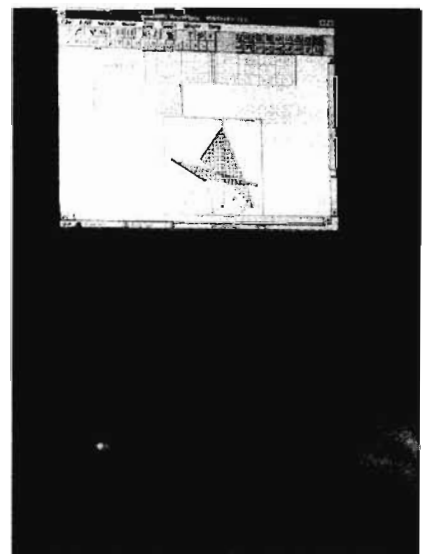
Figure 1: The x-intercept of $y = 6x^3 - 7x - 5$ using the HP-48

But graphing calculators aren’t the only technological change forcing us to re-think our curriculum. Symbolic processors are now becoming widely available at affordable prices. Consider for example the traditional methods used to solve the equation $6x^2 - 7x = 5$. The required steps are: (1) subtract 5 from both sides of the equation; (2) factor the resulting trinomial on the left into a product of binomial factors; (3) set each binomial factor equal to zero; and (4) isolate x in each of the resulting linear equations.

$$6x^2 - 7x = 5$$

- (1) $6x^2 - 7x - 5 = 0$
- (2) $(2x + 1)(3x - 5) = 0$
- (3) $2x + 1 = 0$ and $3x - 5 = 0$
 $2x = -1$ and $3x = 5$
- (4) $x = -1/2$ and $x = 5/3$

We have traditionally drilled students on these steps so they understand each one thoroughly and are able to implement it without error. Computer algebra systems, available for a



At the February workshop, Eric Schulz explained how he uses interactive graphics for use in his multivariable calculus course. (Photo: Jean MacGregor)

decade, execute these steps with a single command like **solve** ($6 \cdot x^2 - 7 \cdot x = 5, x$). While these computer algebra systems have shortcomings — they are expensive, they require a computer facility to run, and they operate as a “black box” (i.e. the problems goes in and the solution comes out without student understanding of what operations happened inside) — we are now seeing these systems being designed specifically for mathematics education and built into inexpensive, portable handheld calculators.

Texas Instruments recently released its TI-92 calculator (suggested retail price: \$250) which can be used to solve the same problem. Figure 2 displays the solution of $6x^2 - 7x = 5$ in a way paralleling the paper-and-pencil process. The existence of such calculators causes us to question whether the steps in algebraic manipulation we’ve taught for years are an example of a skill that will no longer be needed (or at least de-emphasized) in future algebra courses. Twenty-five years ago handheld calculators trivialized some of the rote numerical skills we taught. Calculators today are providing us similar opportunities to focus less on rote symbol-manipulation skills and rather on topics more relevant to current times.

Recently developed precalculus and calculus curriculums now present material that would have been impossible to include in a course that was not supported by graphing calculators. Now that handheld calculators are available with symbolic algebra systems built in, what impacts will this have on our courses? Our students will purchase these tools and come to our class expecting to use them. Do we respond by banning the TI-92 and similar calculators? What does that say about the relevance of the course content? What opportunities for improvement would we have if we modified courses to take advantage of new tools?

I think it is important to continually ask, “Why am I teaching what I’m teaching?” Is a topic included in a course simply because I enjoy it? Is a topic included in a course because I cannot remember it being otherwise? Is a topic included in a course because it is in the textbook? Is a topic included in a course because it is an example of mathematical beauty? Is a topic that is

included in a course rendered obsolete by current technological tools? Has the course remained unchanged for the last ten years while the world has moved on?

I recently acquired a TI-92 calculator in order to learn as much as I can about the device so that I’ll be better equipped to teach my mathematics students in the coming years in a way that is relevant to the times in which we live, learn and work using technological tools commonly available. I did the same with the HP-28S in 1987, the

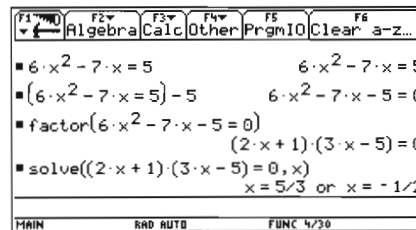


Figure 2: Solution of $6x^2 - 7x = 5$ using the TI-92

HP-48SX in 1990, the TI-85 in 1992 and the HP-48GX in 1994. I have also used the following software packages for mathematical teaching and learning: *Scientific WorkPlace*, *Maple*, *Mathematica*, *Excel*, *Derive*, *Mathcad*, *TesselMania!*, and myriad specialized packages. I communicate with students face-to-face, on the phone, through voice mail and with E-mail. All of this I do because I want to teach today’s students with today’s tools. Yesterday’s tools worked just fine for me, but that was when I was yesterday’s student. My mission is not to teach what I

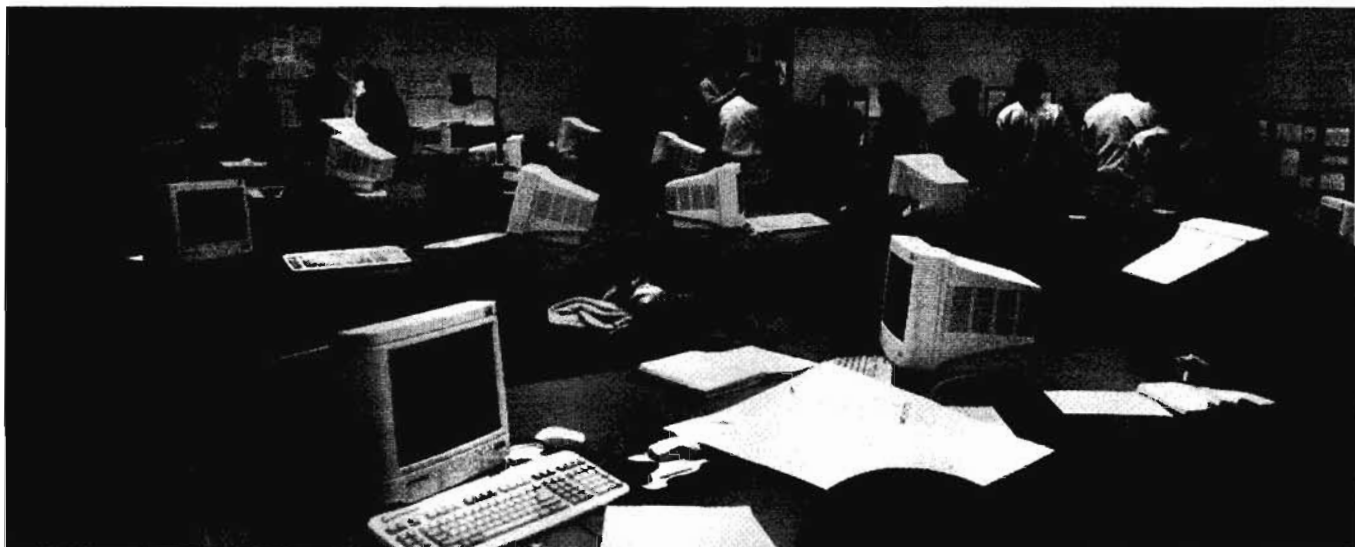
learned the way I learned it, but rather to teach what I know to be important in light of our current society in a way today’s students will understand. I expect the precalculus course my children will take in ten years will bear little resemblance to the precalculus course I completed fifteen years ago.

Keeping current with technology in mathematics does not require familiarity with every make and model of calculator as well as all of the recent versions of mathematical software on each of the major computer platforms. But it does require complete conceptual models of what is currently available, models that have been gained from actual experience with currently available mathematical tools. As mathematicians we cannot begin to seriously discuss the future content of courses without this kind of knowledge. For me to even suggest to a group of faculty that solving a quadratic equation by factoring is no longer a necessary topic for an algebra course would be ludicrous if others present were not aware of the symbolic capabilities of current handheld calculators. From experience with my own efforts as well as with colleagues, I believe this requires a considerable amount of time and effort, but it is absolutely vital to developing and maintaining an effective mathematics program that educates students for their future rather than ours.

Eric Schulz is a mathematics instructor at Walla Walla Community College in Walla Walla, Washington.



Seattle Central Community College students share a computer to explore solutions of the logistic equation using slope field analysis. (Photo: Bob Hereford)



At Seattle Central Community College, the layout of desks, computers and whiteboards has been specifically designed to support collaborative learning in mathematics. (Photo: Bob Hereford)

What Students Say About Group Work in Calculus

by Bobby Righi

“The students repeated over and over how helpful small groups are to students who don’t learn by just reading the book or who never expected to be able to learn math. “

The mathematics faculty at Seattle Central Community College has been discussing, experimenting and sharing ideas about collaborative learning groups in math classes for more than ten years. We have tried this strategy at all levels of the curriculum, and in many different forms—from ignoring it all together to gearing every activity and assessment tool to group work. We are very committed to using groups in our math classes and are convinced that students benefit when we do it well. But how does one do it well? We have worked at collaborative learning long enough to know that there is no concise, step-by-step method that will make each class bloom into a garden of intelligent delight and energy. But there must be something we could do to learn more.

To gain more insight into how students gain from the pedagogical use of group work, we decided to listen to how students describe their experiences in calculus classes where working in groups was part of the class. This was not a statistical study. There was no control group; the students were not a random sample. Faculty members who had taught calculus during the past year were asked to give me names of students I might contact. In some cases I asked for certain students because of comments they had made to me in a classroom evaluation. I tried to make sure there was ethnic and gender diversity among the students interviewed. I wanted some diversity in the

grades received as well, though I did not know what their grades were.

Students who were interviewed:

In spring quarter 1995, I interviewed 17 students who had taken calculus during that year. All the students had taken their calculus with an instructor who used some form of cooperative groups as a teaching and learning tool. Ten of the 17 were female and seven were male; five were students of color; one was deaf. Some had taken pre-calculus courses before coming to Seattle Central, but some had begun there with introductory algebra. They had all passed their calculus classes and some were continuing on to the next math course. The interviews lasted for an hour and took place in groups of two to five students at a time. What follows is an attempt to summarize their comments.

The students had taken the first quarter of calculus with five different instructors and the activities and amount of work assigned as group work rather than individual work varied with instructor. How the groups were organized in their classes also varied: some instructors assigned groups of four during the first week and the students worked in those groups for the whole quarter, some instructors assigned groups but changed the groups during the quarter, some instructors gave group quizzes but let students work in pairs with whomever they were sitting by on the

day of the quiz, so the students' experience was varied. However, all the students interviewed were certain that they had benefitted from studying with other students and were at first concerned about these interviews because they took them to be an indication that math instructors at SCCC might be *reconsidering* the use of groups.

The students' views about groups

The students' comments were moving. A young Vietnamese woman commented, "I took calculus in high school but I didn't understand it all. I made a good grade, too. But I didn't understand it. I felt like an alien from another planet because I didn't know what was going on." She said that working with other students kept her from feeling like this. "This time it (calculus) made sense. Working with other students helped because you could check your ideas and you could learn their shortcuts. I began to understand what I was doing and I didn't feel so strange." An African-American woman made a comment that was echoed by other students over the course of the interviews, "I just think that students learn better from other students. They feel more comfortable. We have a lot of cultures here and students from some cultures feel like they can't ask the teacher. So they ask us and we learn a lot from working together. They won't get it otherwise. We don't just work together in class, we do our homework together and study."

Many of the students credited group work in earlier classes with encouraging them to take calculus and helping them to be successful. Math had always been their downfall and here they were learning calculus, and feeling confident about their understanding!

Perhaps the strongest statement about what groups can mean to students in math classes was made by another young woman, "Working in groups has helped legitimize math for me. When I graduated from high school it really wasn't legitimate for a girl to be outspoken in math. She could explain it to the guy next to her but it really wasn't legitimate. But in this calculus class I'm in a group with other women and getting into it with them

over a math problem means that math becomes a part of our social life and that gives me permission to be good at math because I'm a more social person." This student's powerful statement about finding a voice is relevant for all students, male and female, who feel they are not allowed or expected to speak for any number of reasons.

Many students voiced concern about what would happen when they went on to four-year schools and were faced with math classes where individual competition was key and students were expected to sit quietly. Asked whether they thought any of their group work in calculus would help them cope with that situation they often said that yes, members of their group would continue to study as a group as they moved to other schools together. They also said they would be better equipped to form groups on their own. One student, a male, said, "Even if you don't get into a group situation or the classes are not taught using groups when you go to a larger institution, you are better able because of this experience to either start your own group or to actively able to seek out resources for yourself. You won't be so reserved about asking."

What makes working in groups so helpful?

What activities in class helped these students have such positive feelings about working in groups? What did the

instructors do to encourage and support collaborative learning? In some classes it was only a matter of giving a weekly group quiz. Groups were casual—whomever you sat beside on quiz day was who you handed in your paper with. In this class there was a group project at the end of the quarter. You could choose your group. Homework was graded individually but students were encouraged to work together on it. Worksheets were begun in class and then handed in the next day with four students handing in one worksheet. This class was at the loosely organized end of the cooperative group spectrum.

At the other end of the spectrum was a class in which groups of four had been assigned after the first week, group worksheets were done in class once or twice a week, a weekly quiz was done as a group with one paper handed in per group, homework was handed in and graded by group, and there was an end-of-quarter group project. Students always sat with their group in class. Mid-term tests and final exams were done individually in all of the classes.

From the enthusiastic response from the students, it is clear that any encouragement from the instructor to work together helps students play a more active role in learning. The students had several explicit suggestions for instructors, as well as ideas that were implicit in the discussions.



At Seattle Central Community College, Bobby Righi reacts to a student team's poster presentation on ways calculus is used in real-world settings.



Seattle Central calculus students presenting and discussing their poster sessions on their research into ways differential or integral calculus is at work in the real world. (Photo: Bob Hereford)



Evergreen calculus students working in pairs. (Photo: Steve Davis)

Assigned Groups. Some students felt instructors need to play a strong role in getting students into groups; they should assign students to groups and give guidelines for working as a group. Some students said they would never have the nerve to walk up to other people and try to organize a group. Many students are too shy to do this or come from a culture where this is not done. There was general agreement that the instructor needs to play an active role in forming the groups, though most students wanted to have something to say about who was in their group and suggested allowing students to hand in a short list of other students with whom they would like to work. One young man said that he knows the math classes here are taught using cooperative groups so he begins looking for good group members as soon as he enters the class on the first day.

Training to work in groups. The students thought some guidance about working in groups is necessary, especially if most of the students in the class have never done this before. They felt that the instructor should suggest a list of rules or strategies for helping

students work together. They said that during work on an in-class worksheet some instructors walk around the classroom making sure that each group of students is discussing the assignment rather than only struggling individually. The instructor should play an active role in helping students get to know each other and encouraging them to work together.

Students felt emphasis should be placed on attendance and individual responsibility to the group. One student suggested that many students don't know how to approach another person in the group who is not doing the work; in some cultures this is more difficult than in others. The instructor needs to acknowledge that problems may develop and "give permission" to students to confront group members who are not doing their part. Students could use some help in ways to do this, even some phrases to use to talk to delinquent group members in a constructive way would help.

Instructor awareness of how the groups are working. The students talked about problems with their groups: for example, their work schedules made it impossible for groups to get together outside of class; a member of their group couldn't keep up; a member of their group was lazy or just didn't care. What should an instructor do about this? For the most part, they felt that these problems were "just life" and had to be worked around or worked through. The students didn't feel that it was the instructor's job to solve every difficulty in group work. They did think the instructor needed to know about any serious problems. Some of them felt that in the case of the lazy group member, there should be some way to keep the grade of the other students from suffering because of having a laggard in their group.

We discussed ways an instructor might keep up with how the groups were working and they suggested that after two or three weeks into the quarter, when students had gotten to know each other and while any problems could still be corrected, the instructor might ask for feedback about any difficulties. The instructor might ask students to write a brief description of problems or hand out a short questionnaire asking about any difficulties in the group. These could be done individually and handed in. It

would also be helpful for the instructor to remind students about the importance of the groups working well together, perhaps to briefly go over the group guidelines again. None of the students had been in a class where the instructor had done this.

I pointed out that while we were committed to using groups in our classes, we were concerned that students would resent our devoting 10 or 15 minutes of class time to group process rather than math. The students responded unanimously: group work is so effective that it was important to have the groups work as well as possible and students would appreciate acknowledgment from the instructor that either they were making the groups work or that they needed some assistance.

Design of group assignments. A variety of group assignments were discussed in these interviews: In most classes, students did their *homework* as a group and received a single grade. This was generally felt to be helpful except when some member of the group did not do the work and caused everyone else to get a lower grade. Some grading accommodation should be made if the slacking student can not be brought around by the group.

Students also did *computer labs* in pairs or in groups and sometimes could change partners for each lab project if they chose. This flexibility in partners for the computer labs is a good way to allow advanced students to work together and perhaps take a project further than they might be able to when working individually or in their assigned group.

In one class assignments were written as if the student group were a consulting firm presenting a well-written bid explaining its solutions to a problem. There were five or six of these over the quarter and the design of the assignment required that all students participate in order to complete the project.

In-class worksheets are used in many classes. These can be applications of concepts, sets of problems that review procedural strategies like integration by parts, or problems that require students to synthesize concepts and procedures and apply them in new ways. The application and synthesis worksheets work best in group situations because they require

students to talk over problems in order to understand them, but even drill and practice worksheets are useful to do as a group. In-class worksheets allows the instructor to see the students in action and provides excellent feedback about the level of student understanding and areas where more work needs to be done.

Group quizzes came up in every discussion. Several students said the weekly quiz in their class was always hard and was designed to draw out all of the subtleties of the material covered during the week. It was clear that the students viewed these quizzes as a learning situation because they felt the quiz was a chance to test their knowledge and to be reminded about what they had overlooked; every student did the quiz and then the group collaborated on a new copy of the quiz to hand in. Very few students, if any, could do these quizzes individually, but doing them as a group meant they could depend on others to help; it also meant everyone had a responsibility to come prepared. One student said that in this class he wouldn't give up on hard problems because others were depending on him. This same student said that this was sometimes very stressful because other students wouldn't listen to his views on the problems.

Group quizzes are stressful because the grade depends on the group working well together. Having students work together on homework or other in-class assignments helps train students to work together and makes a good complement to these quizzes.

Capstone projects were assigned in many of the classes. Students were required to work with their group on a project of their choosing and make some type of presentation near the end of the quarter. There was general agreement that these assignments caused intense stress on groups. Any problems with work schedules or personality conflicts were exacerbated by these extended, labor-intensive projects. If an instructor requires such a project, the student said, some acknowledgement of these challenges should be made. Perhaps these projects could be assigned as group projects in groups of the students' own choosing or perhaps these projects should be a requirement some quarters but not others.

Why do instructors teach using cooperative groups?

During each interview I asked students why they thought their instructor put them in groups. They usually said that it was to get them ready for work after college. One student observed that her instructor had "a philosophy of student success." They had been told that it would help them and after trying it for a while, they seemed to be convinced. I wondered if we need to give students a clearer rationale for engaging in group work. I also wondered what kind of answers I would get if I were to ask the teachers of their classes why they used cooperative groups. Do faculty members need to know more about why we do this? When I casually asked some faculty members about the benefits of using cooperative groups, a recurring theme in their responses was that it gave them a window on students' understanding: "I can observe groups and interact with students in class and learn a great deal about what students understand and what misconceptions they have."

Conclusion:

As a result of these interviews, did we learn any more about how to use group work well? After listening to these 17 students and reflecting on their comments, I am strongly reassured about my original reasons for using groups. These reasons were to get students actively involved in their learning, to give them practice in metacognitive thinking and to convince them that mathematics is creative and engrossing. From these interviews I learned that asking students to work together on challenging and somewhat open-ended questions indeed accomplishes this. But until I listened to these students, I didn't realize how powerful a role collaborative learning could play in opening the door to mathematics for students who are not usually successful in math. The students repeated over and over how helpful small groups are to students who don't learn by just reading the book or who never expected to be able to learn math. The overriding impression I got from these interviews was that through talking about the assignments and arguing over concepts



While Shoreline Community College students work through a calculus problem, faculty member Betty Hawkins looks on. (Photo: Shoreline Community College)



Evergreen calculus students working in pairs. (Photo: Steve Davis)

and procedures with other students, the students in these classes felt like the subject was theirs. They have seen in practice that there are many ways to do a problem; they seem to have confidence in their ability to judge the reasonableness of procedures and solutions; and they are excited about their progress.

We can all be more confident that the effort we put into making small-group learning work in our classes is productive and we need not be so shy about making mistakes in trying this. Students are willing to help work out the hitches and should be called on to do so. Even though the students' helpful suggestions in these interviews challenge us to consider even more carefully the way we present material and how much we present, the benefits of teaching in this way make it well worth the effort.

Bobby Righi is a mathematics instructor at Seattle Central Community College.



Phyllis Leonard. (Photo: Jean MacGregor)

Matters of the Spirit

by Phyllis Leonard

“It’s not a question of what I’ll say, but rather what can students do to construct their own knowledge.”

The Washington Center’s Calculus Reform Dissemination Project reunion, held at the Rainbow Lodge in February, was a stimulating, provocative and personally encouraging event. We identified clear successes for our calculus students that resulted from our reform efforts. Successful teaching and learning were charted and celebrated by the group, but we weren’t shy about naming the challenges that remain.

But why am I feeling apologetic and self-conscious amid this success? I’ve been reminded of a couple of interviews I’ve given in recent years regarding my teaching of reform calculus. When I’ve seen my words in print, I’ve felt embarrassed about my exuberance. The articles quote me as saying that I am “teaching what I want to know!” The articles refer to my focus on classroom process. They speak of my feelings of personal satisfaction in my relationships with students and their connections with one another. What self-respecting mathematics teacher (especially a teacher of calculus) would focus on such matters of the heart and soul? Instead, shouldn’t a respectable mathematician speak to matters of “deltas and epsilons,” not forgetting the debate around “proofs” and “meaningful applications”?

Why is it that I consistently find myself speaking to these “other” matters that are more spiritual in nature? And then, why am I uncomfortable with my interest in exploring them? Writing this article has challenged me to explore my discomfort and to find the courage to name these matters as the most respectable and important parts of teaching and learning, especially teaching and learning one of the most dreaded courses in the undergraduate curriculum.

For me, calculus reform has become intensely personal; it is nothing less than a spiritual journey. It has helped me reconcile my values regarding human relationships with the values I wish to represent as a mathematics teacher. It has helped me reconcile the activity I believe is conducive to learning with the atmosphere I design and the values I nurture in the classroom. There has been some redefinition of myself as a teacher, and therefore some remaking of myself as a person. These **are** spiritual matters! If I didn’t believe the students I teach were learning more about calculus and about themselves, and if I didn’t believe that I was being transformed in the process, I would not call this reform successful.

I was ready (personally and professionally) for these questions. I was willing to face the questions alone, but some of the joy in this unfolding process has come from the connections with soulmates I’ve met along the way, some of whom, I am happy to say, are teaching with me at Chemeketa Community College.

In teaching a reform calculus course, I find my time spent on refining questions, setting both short- and long-term student goals and then designing student activities that invite discussion, exploration and problem-solving. I’ve changed what I do to prepare for each class I teach. It’s not a question of what I’ll say, but rather what can students do to construct their own knowledge. Our department requires students to use a graphing calculator throughout our precalculus and calculus program, and therefore the important questions asked in our classes have been drastically changed because of all that students can do with this technology. Students’ questions are deeper, more conceptual and more interesting. Students grapple with these richer questions most successfully with their classmates, collaborating, comparing, contrasting, hypothesizing, arguing and justifying. The

questions stimulate a quality of student understanding and success beyond successes I've witnessed in all my previous teaching experience.

The atmosphere of my classroom has become more inclusive to all students. When students collaborate, student isolation is minimized. The practice of clear communication, respect for one another's ideas and refinement of mathematical understanding have become common classroom themes. As students struggle to articulate their questions about a concept, they are learning far more than calculus; they are learning problem-solving skills in the most general sense, along with habits of inquiry and curiosity. Coming to believe all student have a right to learn what they really want to know has put an entirely different spin on my job description. As a result of reforming my calculus course, I find my students have a better understanding of themselves and their peers, as well as of their mathematics. Reform, I have learned, is not just a matter of tinkering with a syllabus. It has been a matter of redesigning the classroom experience and atmosphere, and redefining myself as a teacher. These are all matters of values.

When our values emerge in our behaviors (our teaching practices), great personal exhilaration and energy gushes forth. Inspired, we move deeper into our calculus courses and then into our department's course offerings beyond calculus. Reform calculus cannot be sustained in a department that hasn't considered pedagogical and curricular reform in algebra and precalculus as well as post-calculus classes. The reunion participants agreed, however, that all mathematics departments face difficult philosophical questions regarding the teaching process and course content far beyond calculus courses.

The invigoration of this work brings personal challenges as well. There is so much exciting work to do! How much of my personal time am I willing to devote to this work? Every "reformer" at the Rainbow Lodge reunion is stirred by the new pedagogy, new technology, new grading strategies, new software, new lessons and new questions. Overload and burn-out become real possibilities. The reform excitement requires clarification of personal boundaries. Sustaining ourselves as healthy individuals, colleagues and family members becomes more challenging as the excitement mounts to embrace all this newness. The practices of healthy living, healthy relationships and clear boundaries between personal and professional time are inextricably woven into the professional decisions that reform demands. Doing the right thing for yourself, we agreed, turns out to be the very best you can do for others.

So often at the Washington Center's calculus reform gatherings, veteran teachers have expressed genuine enjoyment of teaching "after all these years." Many of us exclaim, "I've never had this much fun teaching!" At the same time, we have acknowledged that this work is demanding, tiring and at times contentious. At the February gathering, all these emotions surfaced. Yet the participants agreed that we are committed to mathematics reform and that the right questions are being raised and discussed. These "right" questions address both the content and the process of the teaching of mathematics, and not only that, our basic and very personal values and beliefs about students, their learning and the teaching enterprise. We are transforming, fundamentally—our curriculum and our classrooms and, therefore, our lives.

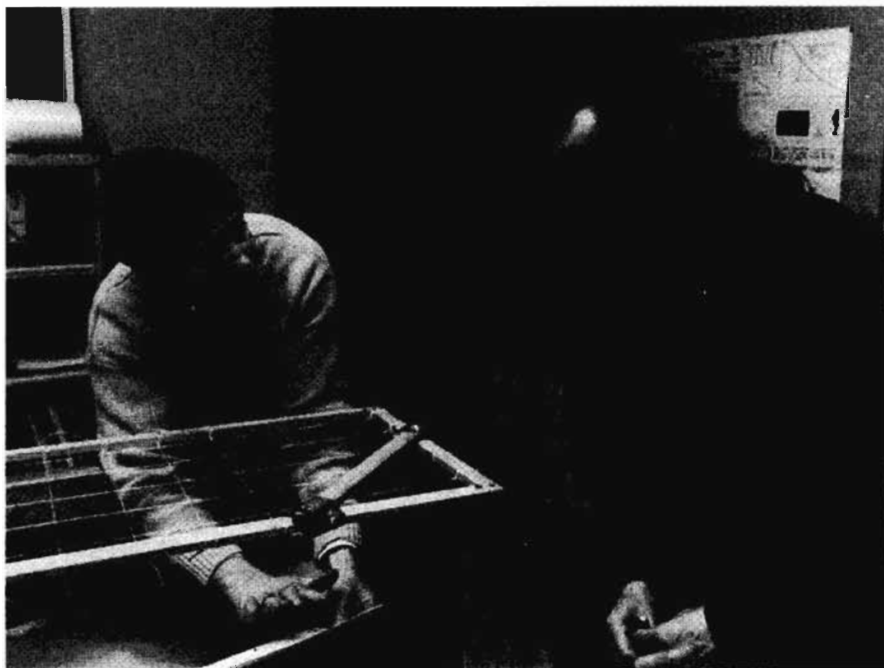
Phyllis Leonard is a faculty member and departmental chair in mathematics at Chemeketa Community College in Salem, Oregon.

"If I didn't believe the students I teach were learning more about calculus and about themselves, and if I didn't believe that I was being transformed in the process, I would not call this reform successful."

Materials Supporting Reform in the Courses Before Calculus

By Janet Ray

Early phases of the calculus reform movement were characterized by enthusiasm for change among faculty, along with a virtual absence of appropriate instructional materials. Ten years of calculus reform have spawned both diverse calculus materials and a recognition that other lower-division and remedial mathematics courses are in need of critical attention. Fortunately, materials to support change in these courses are already emerging. Below is a sampling of newer texts presenting attractive alternatives for mathematics studied before calculus.



Jan Ray discussing a multivariable calculus problem with a Seattle Central student. To visualize uses of tangent planes, students constructed a model of an actual surface. (Photo: Bob Hereford)

Beginning/Intermediate Algebra Level

P. DeMarois & M. McGowan & D. Whitkanac, *Mathematical Investigations: An Introduction to Algebraic Thinking*, Harper Collins, 1996.

Expanded view of what algebra is to include the process of algebraic thinking. Specifically designed with the adult learner in mind. Many novel features.

University of Chicago School Mathematics Project, *Algebra*, Scott Foresman, 1996.

Content integrates geometry, probability, and statistics together with algebra. Although this is not a college-level text, its unusual features make it a text worth considering.

D. Arnold, *Intermediate Algebra: A Discovery Approach*, Addison-Wesley, 1995.

A discovery approach with some work-book-like features. Rule of three emphasized. Calculators supported. Relative to some of the other texts listed, the content is pretty traditional.

P. DeMarois & M. McGowan & D. Whitkanac, *Applying Algebraic Thinking to Data: Concepts and Processes for the Intermediate Algebra Student*, Harper Collins, 1996.

Multiple representations of the function concept, interactive investigations using calculator or computer, concept maps and reflective exercises.

A. Warr & C. Curtis & P. Slingerland, *Interactive Mathematics III (Preliminary Edition)*, Saunders Publishing Company, 1996.

Guided discovery activities, collaborative learning, integrates graphing technology without teaching keystrokes, conceptual and open-ended questions, modeling using the rule of three.

K. Yoshiwara & B. Yoshiwara & I. Drooyan, *Modeling Functions and Graphs (2nd edition)*, PWS, 1996.

Emphasis on linear and exponential growth and modeling. Calculators used in a thoughtful way. Language of functions used informally in the midst of the usual skill development. Traditional (intermediate algebra) content, with good applications and absence of some of the extreme manipulations.

College Algebra/ Precalculus

L. Kime & J. Clark, *Explorations in College Algebra (draft version)*, John Wiley & Sons, 1996.

Algebra from data-based applications. Stresses active involvement, communication of ideas, integration of technology. Content motivated by practical questions arising in science and society.

D. Wells & L. Schmitt, *College Algebra: A View of the World Around Us*, Prentice Hall, 1996.

Uses algebra to understand the world around us through a "Mathematica Looking Glass". Balances use of technology and active learning with traditional content.

D. Burzynsk & W. Ellis & E. Lodi, *Precalculus with Trigonometry, Using the Graphing Calculator*, PWS, 1995.

Four major themes are threaded through the text: describing functions, modeling applied phenomenon, multiple representations, a mathematics resource bank.

Consortium at Harvard, *Precalculus: Functions Modeling Change (draft version)*, 1995. (Available only from the consortium.)

A precalculus book with a reformed calculus approach. Emphasizes multiple representations, modeling and families of functions. A different set of authors from the calculus text with different but compatible philosophies. Good non-traditional problems.

Reform Calculus Dissemination Project Participating Campuses

Washington Community Colleges

Bellevue Community College
Big Bend Community College
Centralia College
Edmonds Community College
Grays Harbor College
Green River Community College
Lower Columbia College
North Seattle Community College
Olympic College
Peninsula College
Pierce College
Seattle Central Community College
Shoreline Community College
South Puget Sound
Community College
South Seattle Community College
Tacoma Community College
Walla Walla Community College
Wenatchee Valley Community College
Whatcom Community College
Yakima Valley Community College

Washington Baccalaureate Colleges and Universities

Eastern Washington University
Heritage College
Pacific Lutheran University
Saint Martin's College
Seattle University
The Evergreen State College
University of Washington
Western Washington University

Washington High Schools

Capital High School, Olympia
Cleveland High School, Seattle
Roosevelt High School, Seattle

Alaska

University of Alaska-Fairbanks

Idaho

University of Idaho

Montana

Montana State University-Bozeman
Salish Kootenai College
University of Montana

Oregon

Eastern Oregon State College
Lewis and Clark College
Linn-Benton Community College
Chemeketa Community College
Portland Community College
Portland State University
Lane Community College

Texas

University of Texas-El Paso

S. Gordon *et al*, *Functioning in the Real World: A Precalculus Experience (Class Test Edition)*, Addison Wesley, 1995.

Focuses on the applications to the world around us, covers a wider than usual set of topics, interesting and non-standard problems.

T. Hungerford, *Contemporary Precalculus*, Saunders College Publishing, 1994.

Explores concepts central to calculus using rule of three. Traditional topics treated while taking full advantage of graphing technology. Real-world problem solving.

Reading for Faculty

Don Cohen (editor), *Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus*, American Association of Two-Year Colleges, 1995.

A comprehensive look at the standards for intellectual development, content and pedagogy applicable to a variety of courses studied by college students before or in lieu of calculus. Includes discussion of the foundation (developmental mathematics) as well as mathematics for technical programs, liberal arts and the prospective elementary school teachers.



As Jan Ray looks on, a student team presents their research, in which they used calculus to model the spread of the AIDS epidemic in King County. (Photo: Bob Hereford)

Marla Parker (editor), *She Does Math! Real-Life Problems from Women on the Job*, Mathematical Association of America (MAA), 1995.

Short biographies of women who use math in their careers from engineering to environmental psychology. Also some interesting problems from each field. Good reading for students as well as faculty.

A. Wayne Roberts (editor), *Calculus, The Dynamics of Change*, Mathematical Association of America Notes #39, 1996.

The latest word on calculus reform, also good insights for curriculum change in general. Includes discussions on planning for change, assessment, as well as some nice exam questions for calculus.

Janet Ray is a co-director of the Washington Center Reform Calculus Dissemination Project and a member of the mathematics department at Seattle Central Community College in Seattle, Washington.



Rob Cole working with Evergreen student teams on fractal geometry problems. (Photo: Debra Gerth)

What Effect Has Reform Calculus Had on Subsequent Mathematics Courses?

by Robert Cole

Within the Washington Center Calculus Consortium, we have loosely defined a "reform" calculus course as any course that contains at least three of the five following characteristics: (1) places relatively equal emphasis on the visual, numerical, symbolic and descriptive aspects of mathematics, the "Rule of Four"; (2) uses some collaborative, or small-group learning exercises; (3) uses writing (and perhaps speaking) to assess student understanding; (4) is heavily based in applications problems; and (5) integrates the use of technology (graphing calculator or computer software) into the course. These characteristics are not unique to the subject of calculus; many math instructors have applied them to courses either before or after calculus. Now we are seeing textbooks that bear the influence of reform calculus emerge for at least three courses that normally follow the calculus sequence: differential equations, linear algebra, and classical analysis.

In January of 1996, three new differential equations texts were published, all showing the influence of calculus reform efforts. David Lomen

and David Lovelock, authors of *Exploring Differential Equations via Graphics and Data (Preliminary Edition)*, (John Wiley & Sons, Inc., 1996) wrote in their forward to the students:

"Our objective is to transform the introductory ordinary differential equations course from the traditional one where you simply learn formal methods of solution, to one where you think, experiment, and comprehend.... Wherever appropriate we implement a 'rule of four,' treating topics from numerical, graphical, analytical, and descriptive viewpoints."

In like fashion, Paul Blanchard, Robert Devaney and Glen Hall, authors of *Differential Equations, (Preliminary Edition)* (PWS Publishing Company, 1996) wrote a book based on their belief in the need for a "radical revision" (their words) of the traditional course. Their approach makes heavy use of computer tools and emphasizes nonlinear equations. Easy-to-use computer software has allowed mathematicians to find and graphically display approximate solutions to nonlinear differential equations — equations that for the most part do not have analytic solutions (that is, no formula can be written that solves the original equation). Most things in nature are best described by non-linear equations. Thus we find that for the first time we can have students investigate far more complicated (and realistic!) models of natural systems than the linear models we've used heretofore. The computer makes possible the investigation of more interesting applications than we could study in the past. Robert Borrelli and Courtney Coleman, authors of *Differential Equations A Modeling Perspective (Preliminary Edition)*, (John Wiley & Sons, Inc., 1996) make this explicit by focusing their book on two principles: modeling and graphical visualization.

The influence of calculus reform efforts is likewise seen in new approaches in linear algebra courses. Virtually every new edition of a standard linear algebra text includes expanded applications sections requiring use of technology packages. Computing technology opens new arenas for visualization of matrix algebra. Indeed, computing technology

renders moot many of the laborious techniques previously taught for evaluating properties of matrices (does anyone recall with pleasure the tedium of grinding out eigenvalues for a 5 by 5 matrix?). Rather than have students focus their efforts upon tedious computational technique, which the computer will do better and faster, we now are able to focus student attention on conceptual understanding and on how to use these concepts with a whole new array of applications taken from different disciplines. Mathematics used in this fashion becomes a tool to understand many different things in the everyday world. Most students today find that this makes mathematics more accessible.

Finally, Michael Reed at Duke University is completing *Fundamental Ideas of Classical Analysis (Manuscript)*, (John Wiley & Sons, Inc., 1995 — Preliminary Edition due 1996), the motivation for which is to approach the subject of analysis in the spirit of calculus reform. Reed specifically wants to connect the subject of analysis to other areas of the mathematics curriculum (something he argues is not the case with current analysis courses), to use the Rule of Four and to make a lean and lively text, rather than a thick handbook of topics. He eliminates many traditional topics while introducing new applications. Reed's goals will most likely be readily embraced by many calculus reformers, yet will rankle other mathematicians. No effort to revise traditional content is universally accepted at first. But clearly calculus reform has influenced Reed to reconfigure his own course and to write a new textbook about the reconfiguration.

Calculus reform, although by no means universally accepted for the calculus sequence, has already inspired individual mathematicians to experiment with the reform techniques in courses following calculus. Authors and publishers alike have picked up this energy and are producing new texts that reflect a reform flavor. The next decade will most likely see a proliferation and growing sophistication of these approaches.

Robert Cole is co-director of the Washington Center Reform Calculus Dissemination Project and a member of the faculty of The Evergreen State College, Olympia, Washington.

Emily Decker Named New Associate Director for Washington Center



Emily Decker, the Washington Center's new associate director.

“Sustainable educational improvement is a lot like sustainable agriculture—you can use general principles, but you have to study local conditions and adapt your practices to the characteristics of the local inhabitants if you want to develop a system that lasts.”

– Emily Decker

Dr. Emily Decker has been appointed as the new associate director of the Washington Center for Improving the Quality of Undergraduate Education. She and her family will be moving to Olympia during the summer and will join us August 1, 1996.

Emily brings a strong teaching background in interdisciplinary work and team-teaching, with many of her courses using multi-media and networked computer technology. This past year, she taught a first-year seminar at the University of Michigan on “Representations of Self,” which focussed on cultural identity and media representation. She has had both formal and informal responsibility with faculty development, sharing her knowledge and experience in performance assessment, the use of portfolios in assessment, and using technology in support of teaching and learning. She is a graduate of Augustana College and the University of Michigan with degrees in literature.

In addition to her years as a classroom teacher, Emily worked directly in a major successful educational reform project at the University of Michigan where she is currently the associate director for writing assessment at the English Composition Board. In her own words, she says, “My ‘claim to fame’ was to replace the on-site essay exam (the placement test for entering students) with a writing portfolio, creating a link between first-year college writing courses and high school curricula across the state.” Emily’s work took her into high schools throughout Michigan and into the many departments and units of a large university that are vested in a particular set of admissions processes. As an example of that, Emily explained that she had to convince the coaches that prospective athletes would not flee to Ohio State to avoid putting a portfolio together. (She was right; they didn’t.)

Emily brings an understanding of how educational organizations work, a trust in the power of students’ abilities to learn, a deep commitment to cultural pluralism, and skill in helping groups and individuals think through and respond to the educational challenges of this period in history.

Washington Center News

Community and Technical Colleges Continue Student Success Work through Multicultural Efforts Project

The State Board for Community and Technical Colleges has initiated a project, "Multicultural Efforts: What's Next?," to enhance the academic success of students of color on campuses throughout the state. The State Board asked the Washington Center to work collaboratively on this project, which is, in some ways, a continuation of the Minority Student Success Project, the State Board's and the Center's collaborative project in the 1989-91 biennium. In 1989, few colleges in Washington had diversity committees or institutional plans related to cultural diversity. Today, all colleges have such plans in place. The intent of the current project is to provide an opportunity for leadership teams from participating colleges to identify and share successes, to review data to consider what next steps could be taken in their work, and to design new strategies to enhance student academic success.

A first group of seven colleges participated in a two-day workshop in February. They were: Bellevue, North Seattle, Pierce, Shoreline, Skagit Valley, South Seattle, and Yakima Valley. Three more cycles of planning and workshops will be held during the next 18 months. The State Board is soliciting applications for a year-long participatory process involving pre-



The South Seattle Community College Multicultural Efforts Project team examines enrollment data at the February conference. Seated from left to right Steve Ford, Mark Palek, Tim Walsh, Michael Castellano, Karen Foss, and Marsha Brown. (Photo: Jean MacGregor)



The Pierce College Multicultural Efforts Project team identifies next steps at the February conference. Seated from left to right are: Agnes Steward (speaking), Thelma White, April Falkin, Douglas Jensen, Michael Darcher, and Kyzyl Fenno-Smith. (Photo: Jean MacGregor)

workshop planning, workshop attendance, and implementation of plans on return to the campus. Workshops will be held November 13-15, 1996 at Rainbow Lodge in North Bend, April 30-May 2, 1997 at Gonzaga University's Bozarth Center in Spokane, and tentatively, in November of 1997 in North Bend. For more information about the project, contact Rhonda Quash Coats, Assistant Director for Student Services and Special Populations, State Board for Community and Technical Colleges, E-mail coats_rhonda/sbctc@ctc.edu or phone 360-753-4694.

Cultural Pluralism Focus to Continue

Cultural pluralism will continue to be a major focus of Washington Center work. The Cultural Pluralism Project carried out collaboratively with the University of Washington in 1992-95 and funded by the Ford Foundation, involved 26 campuses and over 250 individuals in residential summer institutes, institutional planning and seed grant projects on each campus, and a major state-wide conference in January, 1995. The next phase will be developed in consultation with representatives of the 26 planning teams that participated in the project. Participating colleges and universities were Antioch University-Seattle, Central Washington University, Heritage College, Seattle University, The Evergreen State College, University of Washington, University of Washington-Bothell, University of Washington-Tacoma, Washington State University, Western Washington University, Whitworth College, and the following community colleges: Bellevue, Big Bend, Centralia,

Edmonds, Green River, Lower Columbia, North Seattle, Olympic, Seattle Central, Shoreline, Skagit Valley, South Puget Sound, Spokane, Spokane Falls, and Yakima Valley. The first planning meeting to develop recommendations for "next steps" will be held June 17-18, 1996.

Two Additional Institutions Join the Washington Center

Renton Technical College and Northwest Indian College have joined the Washington Center this year. This brings to 46 the number of campuses in Washington state formally involved in the Washington Center network. Norma Goldstein, assistant dean for curriculum, professional development and assessment, and Eric Palo, librarian, are contacts for Renton Technical. Robert Lorence, president, will be the lead contact for Northwest Indian College.

Don Foran named Washington Professor of the Year

Congratulations to Don Foran, humanities instructor at Centralia College, for his recognition as Washington Professor of the Year by the Carnegie Foundation for the Advancement of Teaching. The Carnegie Foundation chose one teacher in each of 49 states and the District of Columbia for this award. Don has taught courses in English, ethics and philosophy at Centralia for the past 10 years, and has also served as an adjunct faculty member at The Evergreen State College. With long-standing interests in interdisciplinary teaching, Don has team-taught in numerous learning communities at Centralia and at Evergreen as well, and has been active in Washington Center activities.



Rhonda Quash Coats (center), Assistant Director for Student Services and Special Populations at the State Board for Community and Technical Colleges and a co-leader of the Multicultural Efforts Project with the Washington Center, joins in discussion at the February conference with Karen Foss (left), Vice President for Student Services at South Seattle Community College, and April Falkin (right), Executive Dean of Instruction at Pierce College. (Photo: Jean MacGregor)

Planning Committee Positions Open

The Center invites nominations for its Planning Committee, which serves in an advisory capacity to the staff of the Center. Committee members are chosen to provide representation from different kinds of colleges (two-year, four-year, public, private) and from different geographic regions of the state and to reflect the range of educational reform initiatives with which the Center is involved. The Planning Committee meets two or three times a year—for an overnight retreat in May or June, and for a day-long meeting in the fall and/or winter. Committee members serve three-year terms. This is a unique opportunity to work with a network of committed educational leaders serving higher education in Washington state. Self-nominations or nominations should be sent to Jeanine Elliott at the Washington Center (E-mail: elliottj@elwha.evergreen.edu or telephone: 360/866-6000, extension 6609).

New Listservs of Interest

Learning Communities: Temple University, the site of a major learning community project, has been hosting a learning community listserv for about a year. To subscribe, send a message to: listserv@vm.temple.edu and leave the subject line blank. The body of your message should say: subscribe learncom Your Name (Replace the words Your Name with your real name, not your e-mail address.)

Collaborative Learning and Interactive Technology in Washington and surrounding environs: In collaboration with Washington State University, we've recently established a listserv on "Collaborative Learning and Interactive Technology." If you are interested in seeing discussion or postings of resources or events in Washington state related to this topic, subscribe by sending a message to listproc@listproc.wsu.edu with the subject line blank. The body of your message should say: sub Int-Tech-Ed Your Name (Replace the words Your Name with your real name, not your e-mail address.)

Announcing the Washington Center's Annual Conference for 1996-97

"Teaching and Learning in the Information Age: Coherence, Context, and Community"

February 14-15, 1997,
Marriott Hotel, SeaTac,
Washington

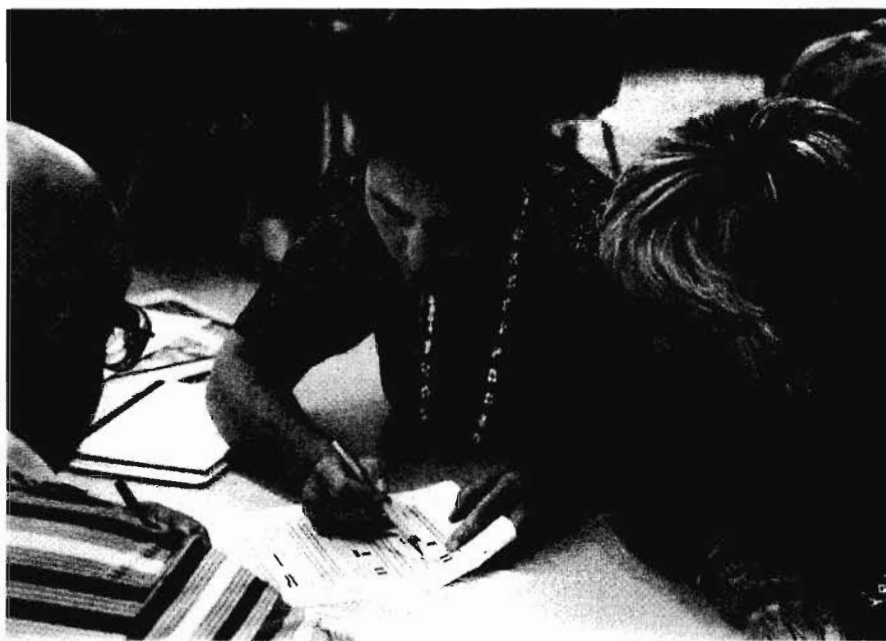
The developing communications technologies and their implications for undergraduate teaching and learning will be at the center of the Washington Center's annual conference. How will these technologies be used? Will they allow students to develop a greater sense of curricular coherence, contextual learning, and community-building? What will learning environments that promote these educational values look like? How will this learning be assessed? Those who have suggestions for programs for this conference are invited to e-mail or call Jeanine Elliott at the Washington Center (E-mail: elliottj@elwha.evergreen.edu; Telephone: 360/866-6000, ext. 6609). Watch for further details in the Fall 1996 issue of the Washington Center *NEWS*.

Interdisciplinary Approaches to Science Institutes Continue in 1995-96

In summer 1995, the Washington Center held three residential institutes for a total of 82 faculty members and administrators from across the disciplines, focussing on interdisciplinary learning communities in the sciences. The institutes, funded by the National Science Foundation's Undergraduate Faculty Enhancement Program, were each an immersion experience in a successful interdisciplinary coordinated studies program for beginning college students. Each one offered a framework for a learning community program out of which participants were invited to invent their own interdisciplinary program designs. "Reflections of Nature" was a 3-day reprise of the very successful 8-day institute held in 1994: it focussed on ways the natural world inspires and underpins many academic disciplines: literature, the visual arts, science and natural history. "Science Shakes the Foundations: Dickens, Darwin and Marx" was an 8-day institute examining the impact of three major 19th century figures, as well as the discourses of different disciplines.



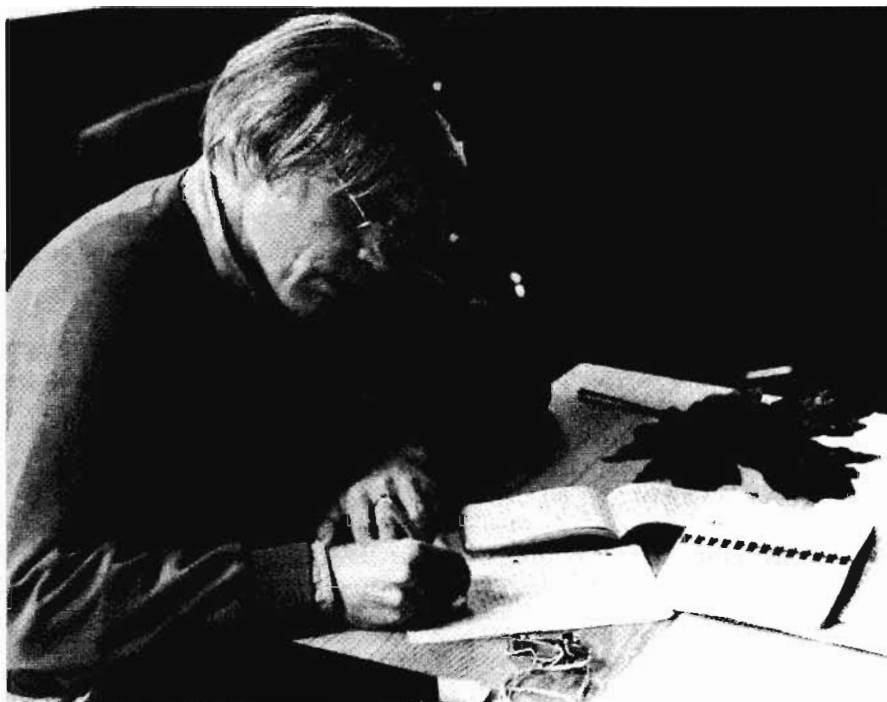
A large group discussion at the "Science Shakes the Foundations: Dickens, Darwin and Marx" Institute. Pictured here are Judy Moore (Yakima Valley Community College), Robert Turner (Western Oregon State College), Joan Stevenson (Western Washington University), Jerry Button (Portland Community College), John Aronson (University of Arizona), Glenna Schubarth (Whitworth College), and Janet Ott (The Evergreen State College).



At "Chaos, Calculus and Comparative Worldviews" Institute, Bill Kubinec (astronomy, College of Charleston), Phyllis Villeneuve (mathematics, South Puget Sound Community College), and Judy Moore (co-director of the NSF Project, and biologist at Yakima Valley Community College) explore the mathematics of mixing in chaotic systems. (Photos: Jean MacGregor)

At the 8-day "Chaos, Calculus and Comparative World Views" Institute in August, participants examined some of the worldviews as seen by western and nonwestern societies, and considered their connections to our emerging scientific and mathematical understanding of chaos. They also explored a variety of activities in science and non-science classes to stimulate student curiosity about the emerging notions of chaos and complexity.

The alumni of each of the 8-day institutes stayed in touch through electronic mail discussion groups, sharing ideas and discussing issues. Each group came together again in April to assess the institute's impact, share successes and discuss continuing challenges. The results that have emerged were just what the project planners had conceived: numbers of faculty and institutions have incorporated interdisciplinary activities into their introductory science classes, and several have launched learning communities that embed science classes. Washington campuses represented at the institutes included the following community colleges: Bellevue, Clark, Edmonds, Grays Harbor, Highline, North Seattle, Pierce, Seattle Central, South Puget Sound, South Seattle, Spokane Falls, and Yakima Valley, and Antioch University-Seattle, Central Washington University, Gonzaga University, Northwest Indian College, Saint Martin's College, The Evergreen State College, Washington State University, Western Washington University, and Whitworth College. Jean MacGregor (co-director, Washington Center) and Judy Moore (Yakima Valley Community College) have co-directed the project.



Rob Knapp, faculty member in physics at The Evergreen State College and one of the "Reflections of Nature" Institute teaching team, practices recording detailed observations in a traditional natural history journal.



A highlight of the "Science Shakes the Foundations: Dickens, Darwin and Marx" Institute was a reenactment of the historic Linnean Society meeting on July 1, 1858 at which Charles Darwin's and Alfred Russel Wallace's papers on natural selection were first presented. Here, the institute participants pose in Victorian attire. (Photos: Jean MacGregor)

Learning Community Programs in Washington - Fall 1995 and Winter 1996

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 offered in Fall Quarter 1995 and Winter Quarter 1996.

Unless otherwise indicated, the learning communities at community colleges are being offered in college transfer Associate 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

Fall Quarter

Coordinated Studies

"The Millennium Approaches"
Laura Burns-Lewis / Written Expression
David Jurji / Cultural Anthropology
Michael Meyer / Fiction

Linked Class

"Composing Psychology"
Robin Jeffers / Developmental English
Helen Taylor / Psychology

Linked Class - Team Taught

"Freedom of the Press or From the Press?"
Ted Centerwall / Mass Media in America
Camilla Yeend / Written Expression

Winter Quarter

Coordinated Studies

"Of Mice & Matter"
Cathy Lyle / Chemistry
Donna Sharpe / Human Development
Kathy Steinert / Biology

Coordinated Studies

"Renaissance 2000: Virtual Workplace"
Robert Hobbs / Science Foundations of Technology
Jack Perry / Business Computers
Bernadette Roberts / Written Expression

Linked Class

"Laughter Through Our Tears"
Gloria Mercer / Cultural Pluralism
Kimberly Pollock / Literature/Written Expression

Linked Class

"Built & Furnished Environment"
Bob Purser / Environmental Design
Connie Wall / Interior Design

Clark College

Fall Quarter

Linked Class

"Landmarks of World Civilization"
Dick Duvall / English
Anita Fisher / History

Linked Class

"Linking Basics for Success"
Kristine Barker / Mathematics
Kris Barnum / Human Development
Don Erskine / English Writing

Linked Class - Team Taught

"Using the Internet to Discover the Global Community of Women"
Bob Hughes / Computer Science
Harriet Levi / Women's Studies

Linked Class - Team Taught

"Writing About the Environment"
Don Erskine / English Writing
Cindy Machida / Environmental Biology

Linked Class

"Landmarks of World Civilization"
Dick Duvall / Research Writing
Anita Fisher / Survey of Western Civilization

Linked Class

"Linking Basics for Success"
Kristine Barker / Mathematics
Kris Barnum / College Success
Don Erskine / Writing

Linked Class - Team Taught

"Writing About the Environment"
Don Erskine / Research Writing
Cindy Machida / Environmental Biology

Columbia Basin College

Winter Quarter

Linked Class

"Everything but the Kitchen Sink"
Gary Culbert / Materials Science
Cliff Wakeman / English Composition

Linked Class

"Learning Opportunity Center"
Sally Beeman / English
Nina Liebler / Mathematics

Eastern Washington University

Winter Quarter

Linked Class - Team Taught

"What's It Mean To Be Green?"
Joelle Fraser / Literature
Paul Lindholdt / Expository Writing

Edmonds Community College

Fall Quarter

Coordinated Studies

"Power Learning: Habits of Highly Effective Students"
Chandler Clifton / Bridge Study Skills
Sandra Cross / Interpersonal Communication
Nancy Kennedy / English Composition

Linked Class

"Common Ground: Clay, Community and Self"
Anne Martin / Sociology
Melissa Newell / Art

Linked Class

"The Greek and Roman World"
Dennis Lamb / Greek, Roman and Ancient World History
Jim O'Donnell / English Composition

Linked Class

Claire Sharpe / Bridge Reading
Elaine Soldwedel / Western Civilization

Linked Class

"Chemath"
Jim Francis / Mathematics
Jill Lund / Chemistry

Linked Class

"Life and Learning"
Ken Marvel / Human Biology
Penny Shively / Bridge Study Skills

Linked Class

"Re-enchanting the Earth"
Charles Mish / Mythology
Holly Hughes / English Composition

Linked Class

"Perceptions of the Earth: Geological Influences of Human Behavior"
Steve Grupp / Geology
Don Smith / Psychology

Winter Quarter

Linked Class

"America's Cultural Conversion"
Anne Martin / Sociology
Margaret Scarborough / English Composition/Literature

Linked Class

"Text, Lives and Videotape"
Sandra Cross / Speech Performance
Kathy Murphy / English Composition

Linked Class

"Capstones"
Steve Grupp / Geology
Pat Nerison / English Composition

Linked Class

"Renaissance and Revolution in Word and Deed"
Bruce Reid / English Composition
Eileen Soldwedel / History of Western Civilization

Linked Class

"Gaining a Competitive Edge for the 21st Century"
Barbara Morgridge / English Writing
Claire Sharpe / Reading

Linked Class

"Law, Justice and Politics"
Merle Deinhard / Political Science
Mike Fitch / Law

Linked Class

"Chemath"
Jill Lund / Chemistry
Melissa Mackay / Algebra

Everett Community College**Fall Quarter****Cluster**

"Women on the Move Toward a Four-Year Degree"
Laura Hedges / Study Skills/Seminar
Holly Hill / Introduction to Writing/Seminar
Paul Marshall / Psychology/Seminar

Winter Quarter**Cluster**

"Women on the Move Toward a Four-Year Degree"
Kristi Francis / English Composition/Seminar
Julia Watts / Sociology/Seminar
Sharon Wellman / Math/Seminar

Gonzaga University**Fall Semester****Linked Class**

"Thought and Expression"
David Calhoun / Critical Thinking
Sara Edlin-Marlowe / Speech Communication
Ken Pickering / Theatre
Patricia Terry / English Composition

Linked Class

"Thought and Expression"
Mark Alfino / Critical Thinking
Gens Johnson / Speech Communication
Phyllis Taufen / English Composition

Linked Class

"Thought and Expression"
Ann Ciasulo / English Composition
Bryan Clayton / Critical Thinking
Harry Hazel / Speech Communication

Spring Semester**Linked Class**

"Thought and Expression"
David Calhoun / Logic
Sarah Edlin-Marlowe / Speech
Phyllis Taufen / English Composition

Linked Class

"Thought and Expression"
David Calhoun / Logic
Jamey Duams / Speech
Michelle Pajer / English Composition

Grays Harbor College**Fall Quarter****Coordinated Studies**

"Success is a Choice, Not a Chance"
Melanie Booth / Writing Development
Trish Dutro / Mathematics Development
Gary Frey / Personal Development
Kathleen Pace / Reading Development

Coordinated Studies

"What Price Freedom?"
Brad Duffy / Speech Communication
Bill Huennekens / Political Science/Speech
Lynne Lerych / English Composition
Gary Murrell / U. S. History

Winter Quarter**Coordinated Studies**

"Success is a Choice, Not a Chance"
Melanie Booth / Writing Development
Trish Dutro / Mathematics Development
Gary Frey / Personal Development
Kathleen Pace / Reading Development

Coordinated Studies

"What Price Freedom?"
Brad Duffy / Fundamentals of Group Discussion
Bill Huennekens / U. S. Government/Speech Fundamentals
Lynne Lerych / English Writing
Gary Murrell / U. S. History

**Green River
Community College**

Fall Quarter

Linked Class - Team Taught
"Business and the Law"
Jim DeLisa / Financial Accounting
Steve Sisson / Law

Linked Class - Team Taught
Roger Knutsen / Computer Application in
Chemistry
Mary Whitfield / Chemistry

Linked Class
Kate Katims / Speech
Sylvia Mantilla / English

Linked Class - Team Taught
"Northwest Mosaic"
Bib Filson / Natural Science and the
Environment
Bruce Haulman / Pacific Northwest History

Linked Class - Team Taught
"Reasoning & Logic"
Jeff Clausen / Reasoning in Everyday Life
Sandy Johanssen / Logic

Linked Class - Team Taught
"Human Sexuality"
John Bush / Social Science
Larry Turnbull / Health Education

Winter Quarter

Linked Class
"Business and the Law"
Jim Delisa / Financial Accounting
Steve Sission / Law

Linked Class
Roger Knutson / Computer Applications in
Chemistry
Mary Whitfield / Chemistry

Linked Class
"Northwest Mosaic"
Bob Filson / Natural Science and the
Environment
Bruce Haulman / Pacific Northwest History

Linked Class
"Reasoning and Logic"
Jeff Clausen / Logic
Sandy Johanson / Reasoning in Everyday
Life

Heritage College

Fall Quarter

Linked Class - Team Taught
Michael Moran / World Civilization
Sr. Terry Mullen / Art History
Loren Schmidt / World Literature

Highline Community College

Fall Quarter

Coordinated Studies
"The Sea - A Mystery Unfolded"
Larry Blades / Literature & Film of the Sea
Gina Erickson / Marine Biology
Chuck Miles / Public Speaking

Winter Quarter

Coordinated Studies
"From Romantic Love To Scientific Revolu-
tion"
Kay Gribble / Western Medieval History
Sydney Stegall / Music Appreciation
Vicki Ropp / Speech

Lower Columbia College

Fall Quarter

Linked Class
"Psychology of Success"
Kathy Demarest / Learning Skills
Julie Preston / English Fundamentals
Michael Strayer / Psychology

Linked Class - Team Taught
"The Balance of Being Human"
Don Correll / Introduction to the Theatre
David McCarthy / English Composition
Carl Roush / Biology

Winter Quarter

Linked Class
"Style and Revolution"
Rita Fontaine / English Literature
Yvette O'Neill / Art

Linked Class
"Hide and Seek"
Don Correll / Drama
Rosemary Powelson / Art

**North Seattle
Community College**

Fall Quarter

Coordinated Studies
"The Learning Place"
Jim Harnish / Twentieth Century American
History
Rick Olguin / Ethnic Studies
Rita Smilkstein / English Composition

Linked Class
"Beginnings: The Modern World Looks for its
Origins"
Larry Hall / Psychology
Bruce Kochis / Modern World History

Linked Class
"Food for Thought"
Ellie Cauldwell / Human Nutrition
Marilyn Smith / English Composition

Winter Quarter

Coordinated Studies
"Ways of Knowing: Science, Religion, and
Myth"
Jim Harnish / World History
Dennis Hibbert / Astronomy
Michael Kischner / Ancient Literature

Linked Class - Team Taught
"Microbes and Man"
Ellie Cauldwell / Microbiology
Suzanne Schlador / Human Anatomy

Peninsula College

Fall Quarter

Coordinated Studies
"Regions of the Olympics and of Ourselves"
Alice Derry / English Literature
Diane Doss / Biology
Kate Reavey / English Composition

Linked Class
Karl Baumwell / Connections
Grace LaFerney / English Composition

Winter Quarter

Linked Class
Dorothy Drain / U.S. History 1850-1900
Grace LaFerney / English Composition

Linked Class
Suzann Bick / Political Science Modern
Government
Dan Stengel / English Composition

Pierce College

Winter Quarter

Linked Class
"Film and Literature - Together Again!"
Jeannie Murphy / English
Scott Kockran / Theater

Linked Class
"Manufacturing Pre-Employment"
Scott Ellis / Job Search Strategies/Manufac-
turing/Computers

Linked Class
"Pre-Employment Corrections Officers
Program"
Bobi Foster / Criminal Justice/Cooperative
Education/First Aid

Pierce College - Puyallup

Fall Quarter

Linked Class
Stefan Anders / English Composition
Christopher Vanneson / Geography

Linked Class - Team Taught
"Looking Out, Looking In"
Nancy Bolle / Developmental English
Norm Komnick / Speech

Winter Quarter

Linked Class - Team Taught
Scott Cochran / Introduction to Film and
Video
Jean Murphy / English Composition

Fall Quarter

Coordinated Studies

"Our Ways of Knowing: African Global Heritage"
Minnie Collins / English
Gilda Sheppard / Sociology
Jawed Zouari / International Studies

Coordinated Studies

"Of Body & Mind"
Liz Campbell / Anatomy & Physiology
David Dawson / English Composition & Literature
Nancy Finley / Psychology

Linked Class

"Ways of Knowing"
Carl Waluconis / English Composition and Humanities

Linked Class - Team Taught

"The Sensual World"
Theolene Bakken / English
Bonnie Cullen / Art

Linked Class-Team Taught

"Critical Issues for the 21st Century"
Tracy Lai / History
J.T. Stewart / English

Linked Class - Team Taught

Shannon Christy / ASL to English Interpreting
Lou Fant / English to ASL Interpreting

Linked Class - Team Taught

"Building for College Success"
Sarah Hogan / ESL
Yilin Sun / ESL

Linked Class - Team Taught

"Reading and Writing for Academic Purposes"
Catalina Huidor / ESL
Verna Sison / ESL

Winter Quarter

Coordinated Studies

"Back to the Beat: Culture & Power in the 20th Century"
James Cauter / Music History
Lynne Dodson / Psychology
Carl Waluconis / English Composition

Coordinated Studies

"Against Tradition: Wars, Sex and Revolution in Asia and the Americas"
John Cannon / Computers
Ileana Leavens / Modern Art/Non-Western Art
Maureen Nutting / World History/The Pacific Century
Nada Oakley / English Literature

Coordinated Studies

"Of Nature and Nurture"
Liz Campbell / Human Anatomy and Physiology
David Dawson / English Composition
Nancy Finley / Psychology

Coordinated Studies

"Kaleidoscope of Life: Family, Culture and Oppression in the U.S."
Kimberly Francisco / Child & Family Studies
Al Hikida / English Composition/Literature
Karen Kiszlewski / Social & Human Services

Linked Class

"Building for College Success"
Yilin Sun / Developmental English/Computer Skills

Linked Class

"Reading and Writing for Academic Purposes"
Verna Sison / ESL/Library/English Composition

Linked Class - Team Taught

"Introduction to American Culture"
Jacqueline George / Developmental Reading/Writing
Cynthia Imanaka / Sociology

Linked Class - Team Taught

"African Americans Making Their Own Way: Cultural Memory as Power"
Minnie Collins / English Composition/African American Literature
Gilda Sheppard / Sociology

Linked Class - Team Taught

"English Composition: Library & Research Skills"
Sarah Beasley / Library
Kelly McHenry / Humanities/Library
J. T. Stewart / English Composition

**Shoreline
Community College**

Fall Quarter

Linked Class - Team Taught

"Language of Microeconomics"
Vince Barnes / Developmental or Analytical
Reading & Writing
Robert Francis / Economics

Linked Class - Team Taught

Dennis Peters / English Composition &
Expository Prose
Paul Shin / Ancient World History

Linked Class - Team Taught

"Looking In, Looking Out"
Pam Dusenberry / Developmental Writing
Laurie Kimpton-Lorence / Developmental
Reading

Winter Quarter

Linked Class

"Looking In, Looking Out"
Pearl Klein / Developmental Reading &
Writing

Linked Class - Team Taught

"The Zoo is You"
Alex Maxwell / Expository Writing
Don McVay / Animal Behavior

Linked Class - Team Taught

"Seeing Beyond the Boundaries"
Pam Dusenberry / English Composition/
Expository Prose
Laurie Kimpton-Lorence / Analytical
Reading & Writing

Linked Class - Team Taught

"Civilization and Culture"
Paul Cerda / English Composition/Expository
Prose
Dale Haefer / Medieval World History
Katherine Hunt / Medieval World Civiliza-
tion

Skagit Valley College

Fall Quarter

Coordinated Studies

"Stories of Life"
Trish Barney / Literature
Robert Pass / Biology
Mike Witmer / Psychology

Linked Class - Team Taught

"Conquering a Continent"
Pat McLatchy / American History
Claus Svendsen / Environmental Studies

Linked Class - Team Taught

"Wordstars: From Pentameter to Pleiades"
Judy Collins / English Poetry
Richard Doyle / Astronomy

Linked Class - Team Taught

"Constructing Sex Roles: A Dramatic
Approach"
Lisa Moulds / Sociology
Donna Taylor / Dramatic Literature

Linked Class - Team Taught

"Constructing Realty: To Be of MC²"
Jerome Chandler / Physics
Andy Friedlander / Dramatic Literature

Linked Class - Team Taught

"KinAesthetics: !Kung to Cool"
Lynn Dunlap / English Composition
Fred Jackson / Anthropology
Ann Reid / Art

Linked Class - Team Taught

"Living Systems in a Changing Society"
Jim Monroe / Biology
David Muga / Sociology

Linked Class - Team Taught

"The Road to the White House"
David Ortiz / Mass Communication
Larry Sult / American Studies
Winter Quarter

Winter Quarter

Linked Class

Lynn Dunlap / Film
Larry Sult / Political Science

Linked Class

David Muga / Cultural Anthropology
Greg Tate / Art: Renaissance to Impression-
ism

Linked Class

Jill Fugate / Literature
Wendy Gray / Current Issues in Business
Management

Linked Class

Richard Doyle / Physical Science
Kathleen Waton / Psychology

Linked Class

Jill Fugate / English
Richard Johnson / Economics

Linked Class

Jovita Lopez / English
David Muga / Sociology

Linked Class - Team Taught

Jerome Chandler / Physics
Andy Friedlander / Dramatic Literature

Linked Class - Team Taught

Jovita Lopez / English
Ann Reid / Art

Linked Class - Team Taught

Trish Barney / English
Linda Moore / English
Mike Witmer / Psychology

**Skagit Valley College
Whidbey Campus**

Fall Quarter

Linked Class

“Let’s Eat - Food and Language”
Cheryl Dickson / Spanish
Sanda Lounsberry / Nutrition

Linked Class - Team Taught

“Delusions of Grandeur - What’s Normal?”
Barbara Moburg / Abnormal Psychology
Les Stanwood / Dramatic Literature

Linked Class - Team Taught

“Searching, Looking for Questions - What’s Religion?”
Louis LaBombard / Religion and Culture
Cheryl Morse / Ethics

Linked Class - Team Taught

“Celebrate Yourself”
Vicki Matzen / Developmental English
Michelle Tatom / Developmental Math

Winter Quarter

Linked Class

“The Human Animal”
Ken Camplese / Biology
Louis LaBombard / Physical Anthropology

Linked Class

“Picture the Earth”
Ken Kendall / Geology
Gary Taylor / Photography

Linked Class - Team Taught

“It’s Greek to Me”
Barbara Moburg / World Civilizations
Les Stanwood / The Arts in Humanities

Linked Class - Team Taught

“Taking Care of Business”
Sue Canny / Business
Jerry Fuller / Literature

**South Puget Sound
Community College**

Winter Quarter

Cluster

“The Garden in American Thought and Experience”
Lois Fenske / Economic History
Michael Shurgot / English Literature
Jim Strong / Environmental Science

Linked Class

Kitty Carlson / College Writing
Karen Healy / Child Development

Linked Class

Walter Cone / Electronics
Sherry Sullivan / College Writing

**South Seattle
Community College**

Fall Quarter

Coordinated Studies

“COM³: Compute, Compose, Comprehend”
Judy Bentley / Writing
Ted Coskey / Math
Tim Walsh / Reading and Study Skills

Spokane Community College

Fall Quarter

Coordinated Studies

“Ways of Knowing”
Scott Orme / English Composition
Carolyn Wall / College Reading & Study Skills
Lynn West / English Literature or Fiction

Linked Class

“Ourselves Among Others”
Val Clark / Intercultural Communication
Mita Sen / English Composition

Linked Class

“Looking Good in Print”
Jackie Crowe / Basic Computer Systems
Melodye Wiens / English Writing Improvement

Winter Quarter

Coordinated Studies

“The American Family: Its History and Hope”
Scott Finnie / Sociology
Gary Gustafson / American Civilization
Linda Seppa-Salisbury / Speech

Linked Class - Team Taught

“Adrift Alone in the Cosmos”
Jim Roth / American Literature
Lynn West / English Composition

Linked Class - Team Taught

“The Write and the Wrong”
Scott Kramer / Philosophy/Ethics
Scott Orme / English Composition

**Spokane Falls
Community College****Fall Quarter****Coordinated Studies**

"Romanticism to Reality: The Evolution of
Modern Europe"

Robert Farrar / Modern Western Civilization

Almut McAuley / Musical Events

Wayne Smith / Music History and English
Composition

Linked Class - Team Taught

Carol Knuttgen / Reading Improvement &
English Study Skills

Tom Nersteeg / Writing Lab

Linked Class - Team Taught

Nel Hellenberg / Literature

Pat Nasburg / ESL Conversation

Linked Class - Team Taught

Jeanette Kirishian / Non-Western Art

Lori Monnastes / English Composition

Linked Class - Team Taught

Kialynn Glubrecht / Elementary Algebra

Jan Swinton / English Study Skills

Linked Class - Team Taught

Steve Reames / World Literature/English
Composition

Linked Class -Team Taught

Susan McGrew / English Composition

Craig Rickett / Theatre

Linked Class - Team Taught

Molly Gunderson / Literature

Sally Nick / English Composition

Winter Quarter**Coordinated Studies**

"Leonardo to Voltaire: A Renaissance of
Ideas and Images"

Robert Farrar / History of Western Civiliza-
tion

Barbara Fulsaa / Library

Nel Hellenberg / English Composition

Carolyn Stephens / Renaissance/Broque Art
History

Linked Class - Team Taught

"Literature of Indigenous People"

Almut McAuley / English Composition/
Humanities

C. Bryan West / Native American &

Southern African Literature/Humanities

Linked Class - Team Taught

Steve Reames / English Reading

Ed Reynolds / English Writing

Linked Class - Team Taught

Heather Keast / Literature

LaVonne Weller / English Composition

Linked Class - Team Taught

"Non-Western Art: Extending our Vision"

Jeanette Kirishian / Art

Lori Monnastes / English Composition

Linked Class - Team Taught

Carol Knuttgen / Reading/Study Skills

Gary Wolf / Chemistry

Tacoma Community College**Fall Quarter****Linked Class**

"Getting it Together"

Georgia McDade / English Composition &
Humanities

Linked Class - Team Taught

"The Now and Future You"

Violetta Clee / Beginning Writing

Theophilus Mungen / College Success

Seminar and Career & Life Planning

Linked Class - Team Taught

"Math Anxiety"

Karen Clark / Elementary Algebra

Diane Nason / Human Development

Linked Class - Team Taught

"Getting it Together"

Tamara Kuzmenkov / English Composition

Montserrat Linkletter / Spanish

Linked Class - Team Taught

"Getting it Together"

Marlene Bosanko / English Composition

Brian Duchan / 17th, 18th Century U. S.
History

Winter Quarter**Linked Class - Team Taught**

"Food for Thought"

Marlene Bosanko / English Composition/
Literature

Tamrara Kuzmenkov / English Composition/
Humanities

Linked Class - Team Taught

"Journeys"

Paul Clee / English/Photography

Violetta Clee / English/Humanities

**Walla Walla
Community College**

Fall Quarter

Linked Class

Joanne Burris / Developmental Reading
Peggy-Joyce Grable / Developmental Writing

Linked Class / Team Taught

Barbara Blasey / Civil Engineering
Technology
Greg Farrens / Irrigation Technology

Winter Quarter

Linked Class

Joanne Burris / Reading
Peggy-Joyce Grable / Writing

**Western Washington
University**

Fall Quarter

Cluster

“The Media and American Politics”
Tim Pilgrim / Introduction to Mass Media/
Seminar
Steven Snow / The American Political
System/Seminar

Federated Learning Community

“Law and Diversity”
Connie Faulkner / American Political System
Rand Jack / American Legal System
Marian Rodriguez / Communication,
Negotiation & Conflict Resolution

Winter Quarter

Cluster

“Politics and the Internet”
Jim Hearne / Computer Science
Steven Snow / Political Science

Federated Learning Community

“Law and Diversity”
Connie Faulkner / Economics
Rand Jack / Constitution: Government Power
Marian Rodriguez / Seminar

Fall Quarter

Coordinated Studies

“Humans in Nature: Reflections on the Human Environment”
Denny Konshak / English
Eric Mould / Biology

Linked Class - Team Taught

“Race Ethnicity & Nationalism: Issues in the Social Sciences”
Eric Anderson / Anthropology
Tim Jeske / Political Science
Chuck Sasaki / Sociology
Inga Wiehl / English Composition

Linked Class - Team Taught

Kathy Calvert / College Seminar
Judy Moore / Biology

Linked Class - Team Taught

Judy Moore / Biology
Tom Mount / College Seminar

Winter Quarter

Linked Class - Team Taught

“Eco-Write Now!”
Mark Fuzie / English Composition
Eric Mould / Environmental Biology

Linked Class - Team Taught

“Men, Women, and Meaning Making in Literature”
Shannon Hopkins / English Composition
Gordon Koestler / English Literature

Linked Class - Team Taught

“Facts & Flicks: Mexico through history and cinema”
Jamie Donaldson / History of Mexico
Denny Konshak / Cinema

Linked Class - Team Taught

“Biomathics: Mathology 101”
Mike Harves / Biology
Bev Parnell / Algebra

Linked Class - Team Taught

“Know Thy Neighbor As Thyself”
Jamie Donaldson / Latin American History
Jill Widner / English Composition

Linked Class-Team Taught

“Composing Higher Realities for Fun & Profit”
Mark Fuzie / English Composition
Dusty Rittenbach / Physics

Linked Class

“Mind Over Math”
Kathy Calvert / Math Anxiety
Carolyn Gregory / Pre Algebra

Linked Class

“Reading and Writing in Latin America”
Denny Konshak / English Composition/Latin American Fiction

**Other large
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 addressing interdisciplinary themes or questions. For information on this year's programs, write to the Washington Center.

The University of Washington, offers a large Freshman Interest Group (FIGs) program to entering students, wherein cohorts of 25 students take a cluster of three classes, with a freshman seminar taught by a student peer advisor. Transfer and Returning Student Interest Groups (TRIGs), modelled on the FIG program, serves transfer and returning students in their first quarter to build a coherent pathway into the major.

Washington State University offers the PAWS (Partners in Achieving WAZZU Success) program. This living/learning community approach is a collaboration between residential and academic sectors. Clusters of 20 students live together in a residence hall, enroll in a common course, and meet frequently out of class with the professor of that course. Students also enroll in an orientation course offered by peer academic advisors who live on the same floor with the students.

Upcoming Washington Center Workshops and Conferences

June 17-18, 1996: Cultural Pluralism Planning Meeting, at Rainbow Lodge, North Bend.

June 20-21, 1996, Washington Center Planning Committee, at The Evergreen State College, Olympia.

June 23-28, 1996, Institute on Curricular Innovations in Software Engineering, sponsored by The Evergreen State College in collaboration with the Washington Center. Funded by the National Science Foundation—Computer and Information Science Engineering Section, at The Evergreen State College, Olympia.

July 12-13, 1996, Workshop on New Approaches to Teaching Pre-calculus and Calculus, sponsored by the Washington Reform Calculus Dissemination Project, funded by the National Science Foundation, at The Evergreen State College, Olympia.

October 31-November 1, 1996, Washington Center Reform Calculus Network Conference, at Rainbow Lodge, North Bend.

November 13-15, 1996, Multicultural Efforts Project Conference, in collaboration with the State Board for Community and Technical Colleges, North Bend.

February 13-14, 1997, "Teaching and Learning in the Information Age: Coherence, Context, and Community," Washington Center Annual Conference, at the Marriott Hotel, SeaTac.

April 24-25, 1997, 7th Annual Eastern Washington Curriculum Planning Retreat, at Gonzaga University's Bozarth Center, Spokane.

April 30-May 2, 1997, Multicultural Efforts Project Conference, in collaboration with the State Board for Community and Technical Colleges, at Gonzaga University's Bozarth Center, Spokane.

May 15-16, 1997, 11th Annual Western Washington Curriculum Planning Retreat, at Rainbow Lodge, North Bend.

November 1-2, 1996, State-wide Faculty and Staff of Color Conference, at Central Washington University, Ellensburg.

Other Events of Interest

Mailing List

Please return this form if you would like to be added to,
or deleted from our mailing list

Name _____

Department _____

Institution _____

Address _____

Send to: Mailing List
Washington Center, L 2211
The Evergreen State College
Olympia, WA, 98505
or call (360) 866-6000, Ext. 6611.

Washington Center Planning Committee

Bellevue Community College: David Jurji and Michael Righi

Eastern Washington University: Judith Kaufman

North Seattle Community College: Willard Bill, Jim Harnish, Rita Smilkstein

Seattle Central Community College: Valerie Bystrom, Rochelle dela Cruz, Ron Hamberg, and Rosetta Hunter

Seattle University: Bernard Steckler

Spokane Falls Community College: Ron Johns and Steven Reames

Tacoma Community College: Marlene Bosanko and Kathi Hiyane-Brown

The Evergreen State College: Magda Costantino, Virginia Darney, Joye Hardiman, Lee Lyttle, and Barbara Leigh Smith

The University of Washington: Louis Fox and Anne Loustau

Yakima Valley Community College: Judy Moore and Gary Tollefson

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Sandra Abrams, Secretary

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 collaboration among member institutions. Established with funding from the Exxon and Ford Foundations, the Center is now supported by the Washington State Legislature.

■ Includes 46 participating institutions: all of the state's public four-year institutions and community colleges, two technical colleges, one tribal college and ten independent colleges.

■ Supports and coordinates the development of interdisciplinary "learning community" programs, inter-institutional faculty exchanges, curriculum reform initiatives in science, mathematics and cultural pluralism, and offers conferences, seminars and technical assistance on effective approaches to teaching and learning.

 Washington Center
for Improving the Quality of
Undergraduate Education

The Evergreen State College
Olympia, Washington 98505

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