

Center for Learning and Teaching in the West

Introduction

A consortium of five universities, Portland State University, Montana State University, the University of Montana, Colorado State University, and the University of Northern Colorado, in partnership with community and tribal colleges, and school districts in diverse settings, jointly propose the Center for Learning and Teaching in the West. Each consortium member brings to this partnership unique strengths in the areas of professional development, advanced degree programs, science and mathematics education research, innovative delivery systems, and experiences in systemic collaborations.

The primary goal of the Center is to increase the number and qualifications of future leaders in mathematics and science education through three integrated components: (1) a sequence of well-articulated technology-based, professional development programs for middle and high school teachers (2) a doctoral component that includes a mixture of coursework, field experiences, and research investigations, and (3) a dynamic research component that will advance our knowledge of professional development, use technology to enhance teaching and learning, and develop a diverse teaching workforce.

This project will address the growing shortage of qualified mathematics and science teachers at the middle and high school levels; the particular need for mathematics and science teachers and leaders in schools with high minority enrollments which are among the lowest in student achievement and are often isolated from the main stream by lack of resources, location, or both; the need to understand how technology, particularly distance delivery, can improve teaching and learning; the need for doctoral and post-doctoral programs to serve students where they live and work and to prepare them for leadership roles in science and mathematics education.

The Center will offer a continuum of experiences enabling participants at all levels to improve their understanding of current developments in science, mathematics and pedagogy; to make sound decisions to improve student learning; and to rigorously assess the results.

Project Characteristics

Teacher Professional Development

This component will involve a partnership between the university campuses, the Portland Public Schools (Oregon), and three community colleges as well as rural schools on the Ft. Belknap, Flathead and Crow Reservations (Montana); the Denver Public Schools and nearby districts in (Colorado).

The professional development program will address three needs strongly voiced by the participating districts. The *first* need is to help the schools fill their need for an adequate number of qualified middle and high school mathematics and science teachers. To address this need, the schools have requested content-focused coursework for elementary-certified instructors now teaching mathematics and science at the middle school level, and for middle-school certified teachers who, given

additional preparation, could staff hard-to-fill SMET positions in high schools. The *second* need is training in assessment, particularly how to design and interpret student performance assessments now required in all three states, and how to align assessment with state standards recently adopted in Oregon, Montana and Colorado that are both more content-rich and more inquiry-oriented than previous versions. The *third* need is for ongoing professional development in ways to enhance student learning using varied classroom technologies and Internet resources.

Each of the selected districts includes many schools serving minority students in low income neighborhoods. These schools are often isolated from the mainstream by lack of resources, rural or inner city location, or both. The partners have agreed that the Center’s professional development activities will target these high need schools.

At the Districts’ urging, the Center will provide graduate credit for all professional development offerings, and package the credits so that they can lead toward graduate degrees. This will provide an incentive for teachers to continue their professional learning in the future. It is hoped that many will eventually pursue post-masters and doctoral preparation provided by the Center.

During the first 2 years of the project, the core Center courses will be developed collaboratively by university faculty, Teacher Leaders employed by the Center and their districts, and graduate Fellows. Each of the core offerings will be a 3-credit masters level course offered on-line. Course development and implementation responsibilities will be shared by the Center partners, and will be funded by designated professional development monies. The courses offered for secondary and middle school mathematics and science teachers are shown below.

	Standards-Based <i>Mathematics</i> Content	Integrating <i>Mathematics &</i> <i>Science</i>	Grade Appropriate <i>Mathematics</i> Pedagogy	Assessment/ Outreach
Secondary	X	X	X	X
Middle Grades	X	X	X	X

	Standards-Based <i>Science</i> Content	Integrating <i>Mathematics &</i> <i>Science</i>	Grade Appropriate <i>Science</i> Pedagogy	Assessment/ Outreach
Secondary	X	X	X	X
Middle Grades	X	X	X	X

The Center will provide significant on-site support linked to the courses above, and to the three professional development themes selected by the districts (see above) Five Teacher Leaders in each state, 15 in all, will be selected to work with the Center districts. These specialists will be employed jointly by the Center and the districts. They will design balanced professional development programs within the districts served, act as field supervisors for Center Fellows participating in the field experiences, and interact with the Center’s four research collaboratives. The Teacher Leaders will also

enroll in selected doctoral courses (described below), with many expected to continue to earn a doctoral degree.

Graduate, Post-Doctoral and Internship Programs

During the Center's first five years, 75 doctoral and postdoctoral students Fellows will have completed the Center's core curriculum. Each Fellow must be accepted into a doctoral or postdoctoral program in science, mathematics or education at a Center campus. As part of the doctoral or postdoctoral program, each Fellow will complete 27 - 45 credits of coursework and field experiences, selecting among the integrated triads shown below:

Triad One: Teaching & Learning This triad will present Fellows with models for teaching and learning from the social sciences and neuroscience; present current research on teaching and learning in SMET disciplines, review a range of formal to semi-formal classroom research models; and involve each participant in an internship in an exemplary classroom at one of the Center campuses or schools, and in carrying out a collaborative classroom research project. Courses include: *Teaching and Learning in Science and Mathematics (3 cr)*, *Models for Research in Teaching and Learning (3 cr)*, *Advanced Teaching Field Experience/Seminar (3 cr)*.

Triad Two: Curriculum, Assessment and Evaluation This triad will involve Fellows in the design and analysis of curricula and curriculum materials; in facilitating curriculum and standards design efforts; will introduce multiple models for classroom, district and program assessment, and will involve each participant in contributing to evaluation research on a component of the Center's campus or K-12 activities. Courses include: *Curriculum Design in Science and Mathematics (3 cr)*, *Assessment and Evaluation (3 cr)*, *Evaluation Field Experience/Seminar (3 cr)*.

Triad Three: Diversity and Equity This triad will involve Fellows in exploring barriers to diversity and equity in science and mathematics education, effective strategies for increasing participation and retention in SMET fields for all students, and for designing educational changes to last. Each participant will complete an internship at a Center school or community college campus with high minority enrollments. While on site, the Fellows will contribute to classroom and professional development activities, and to collaborative research projects occurring at the sites. Courses include: *Diversity and Equity in Science and Mathematics Education (3 cr)*, *Creating and Sustaining Educational Change: School and Community Models (3 cr)*, *Diversity and Equity Field Experience/Seminar (3 cr)*.

Triad Four: Professional Development During this triad students will be introduced to current models for quality professional development drawn from education and other fields; become familiar with exemplar programs at the regional and national level; study the uses, abuses, and necessary areas of research on the roles of technology in SMET education professional development; and work with a team to design, implement and assess a component of one of the ongoing professional development projects sponsored by the Center. Courses include: *Models of Professional Development (3 cr)*, *Technology in the Science and Mathematics Classroom (3 cr)*, *Professional Development Field Experience/Seminar (3 cr)*.

Triad Five: Public Policy and Future Planning Fellows enrolled in this triad will complete a course on the underlying concepts, investigative processes and emerging directions in the sciences or mathematics; explore historical and current forces driving reform, or protecting the status quo, in science and mathematics education; participate in a public policy internship; and contribute to a SMET education policy study with the potential to inform decision-makers at the regional or national level. Courses include: *Concepts and Processes in Mathematics (3 cr)* **or** *Concepts and Processes in Science (3 cr)*, *Contemporary Issues in Science and Mathematics Education (3 cr)*, *Public Policy Field Experience & Seminar (3 cr)*.

Each campus will take the lead in developing one triad for the Center, offering two courses and a linked field experience annually thereafter. Each lead instructor will establish a course development team including at least two faculty from other campuses. The team will work together to design the course, and implement the first 1-2 offerings together. As campus staffing and faculty interests change, the leadership for a particular course or triad may rotate to the campus of any of the team members.

It is expected that all 15 courses and internships in the Center's core curriculum will be offered by distance delivery, with 15 - 20 students drawn from all five campuses participating in each offering. Two of the partner campuses, Montana State University and the University of Montana, have eight years of experience in offering distance delivery courses via the Internet to middle, high school, and community college mathematics and science instructors enrolled in graduate programs. Faculty in the sciences, mathematics and education on these campuses have dealt with course delivery and quality issues, such as fostering rich seminar discussions that engage students throughout the semester; familiarizing graduate students in fields like organic chemistry and mathematics with new modeling software, or with the intricacies of the TI-92 graphics calculator; and providing distance students with ample laboratory and field experiences, including opportunities to utilize via computer scientific instrumentation available on campus. Portland State University faculty use videoconferencing technology to provide graduate coursework to middle school mathematics teachers, and have disseminated the model regionally by inviting other faculty and their students to join the classes. The faculty at MSU, the U of M and PSU will comprise a resource to the Center in the development of high quality, interactive graduate courses using multiple distance delivery strategies.

The final component of the Center's doctoral and postdoctoral preparation strand is a Center Summer Institute series. During the first 5 years of the Center's operation, each university campus will host at least one 2-week summer professional development institute, and a second institute focused on a research theme.

Research Program and Focus

The Center will establish a research agenda with opportunities for engagement of Fellows, faculty, graduate and post-graduate students at all levels, and in-service teacher leaders. Research activities will be coordinated and expressed through coursework, memberships in collaborative research groups, doctoral dissertations, and evaluation internships.

Building awareness of research and evaluation models and providing preliminary research experiences -- Center Fellows will be formally introduced to educational research and evaluation models in each of the triads. These courses will give an overview of a variety of investigative models, ranging from relatively informal and participatory approaches, such as teacher-led action research or a self study conducted by a school, to more formal models, for example, experimental studies, large-scale survey research, or a summative evaluation conducted by an external evaluator. In addition, each triad will engage participants in at least two research or evaluation projects. To illustrate, research experiences embedded in each of the three courses of Triad 3, *Diversity and Equity*, may include:

Diversity and Equity in Science and Mathematics Education - Participants may design and conduct a qualitative study of middle school science and mathematics experiences and attitudes, connecting their findings to patterns of gender and/or minority issues reported in course readings.

Creating and Sustaining Educational Change: School and Community Models - Participants may assist a team of parents and school personnel in data gathering to inform decision-making for the middle school mathematics program, for example, by locating and synthesizing disaggregated student performance data available in local, state and national databases.

Diversity and Equity Field Experience/Seminar - Participants may be assigned to Center middle schools piloting science programs that involve underrepresented students in community-based problem-solving, science inquiry, and/or “doing science as it is practiced by scientists”. Working in site teams, course participants could conduct in-depth case studies of each program, preparing a joint article on the potential of such programs to affect underrepresented students’ learning and engagement.

Practicing research as a member of a collaborative -- Each Fellow will join one of the Center’s collaborative research groups, each carrying out research on a common theme. The themes address issues of national concern in science and mathematics education, build upon the expertise and interests of Center faculty and institutions, and connect and extend the topics introduced in Triads 1 - 5. The current descriptions of the research group themes and formulation of initial research questions are summarized below:

Cognitive Development and Outcomes Assessment - What do current studies on learning imply about best practices for teaching math and science? What are the barriers to changing teaching methodologies and how can they be addressed effectively? What is the evidence that new standards in science and mathematics education (state, national) effectively assess and/or promote student learning?

Equity, Accessibility, and Professional Development - Why is it so hard to increase underrepresented students’ participation in mathematics and science, and what can be done

about it? How can distance learning technologies best promote student learning and teacher knowledge in science and mathematics?

Distance delivery plays a critical role in the teacher professional development and doctoral preparation components of this project and will increasingly affect mathematics and science education at all levels nationally. The mission of the second research group will include critically evaluating the promises met, compromises struck, and directions needed to improve teacher knowledge and student learning through distance delivery.

Each collaborative research group will develop a long range research plan, initiate joint investigations, share and critique findings, conduct ongoing electronic discussions, identify and pursue appropriate publication outlets for members' work, and support and advise graduate student members in their thesis and dissertation work. Communication will take place on-line, and during an annual research forum and retreat arranged by each collaborative.

Leading collaborative research -- Doctoral and Postdoctoral Fellows conducting dissertation or post-dissertation studies may apply for a research stipend to support their work. Proposals involving cooperative research within or between Center collaboratives will be given priority for funding, especially those involving "early career" masters and doctoral students in support roles.

Participating in evaluation internships -- See below.

Evaluation

Dr. Arlen Gullickson, Director of the Evaluation Center, Western Michigan University, will oversee both the formative and summative evaluation of the project. Gullickson will facilitate the design of a detailed evaluation plan, and provide consultation to the on-site evaluator and others participating in the on-going assessment of the project. Gullickson will work in coordination with Linda Adelson, the on-site evaluation specialist for the Center. Both evaluators practice a participatory form of evaluation, involving project participants at all levels.

Areas of emphasis in the evaluation will include: (1) the impact of the professional development component on teacher knowledge and practice, and on student learning; (2) the impact of the core curriculum and research collaboratives as evidenced by the performance of the Fellows as teachers, researchers, professional development facilitators and educational leaders; (3) the effectiveness of the distance learning models utilized by the Center; and (4) the sustainability of the Center's academic, professional development and research programs.

Center Fellows will contribute to many components of the Center evaluation. The evaluators will work with Triad 2 faculty to plan class projects for the *Assessment and Evaluation* course and the *Evaluation Field Experience* that will be part of the core evaluation. Each year, five to eight Fellows will be selected to work for the project as Evaluation interns. These interns will participate in all phases of the evaluation, plan a 4-day evaluation conference for the Center on a special topic; and receive support to travel to national conferences to present their work. Through the work of the evaluators, the doctoral interns, college faculty and K-12

partners will acquire powerful tools for assessing their own classrooms and programs, and for modeling and transmitting these skills to others.

Project Staff

Dr. Elisabeth Swanson is the Director of the Science/Math Resource Center, Associate Professor of Science Education, MSU, and heads the STEP Project, an NSF Collaborative for Excellence in Teacher Preparation. She will collaborate closely with **George Tuthill**, an MSU Physics Department faculty member and **Ted Hodgson**, Mathematical Sciences, MSU.

Dr. Edward E. Geary is the Director of the Center for Science, Mathematics, and Technology Education and a Professor of Earth Resources at CSU.

Dr. Libby Krussel, is an Associate Professor in the Department of Mathematical Sciences at The U of M, teaches courses for preservice mathematics teachers and conducts research on undergraduate teaching and learning of mathematics.

Dr. Robert Mayes, Mathematics Department, UNC, directs the Mathematics and Science Teaching Center and conducts research on cognition and affect in algebra and geometry.

Susan Price Montag is the K-12 Science Coordinator, Portland Public Schools, and served as a mathematics teacher, curriculum specialist, and administrator for 25 years. The district serves 56,000 students with over 3,500 classroom teachers.

Dr. Carl C. Wamser is a Professor of Chemistry at Portland State University. His research involves solar energy conversion by artificial photosynthesis, web-based and computer-based instruction in organic chemistry, and science inquiry teaching and learning for all students. He will collaborate closely with **J. Michael Shaughnessy**, Director, Math Education Ph.D. Program, and **William G. Becker**, Center for Science Education, both at PSU.

Evaluation Staff

Dr. Arlen Gullickson is the Director of the Evaluation Center and Professor of Education, Western Michigan University, and chairs the Joint Committee on Standards for Educational Evaluation representing 17 professional organizations.

Linda Adelson is the Lead Evaluator for the NSF STEP Collaborative. Adelson served for more than 20 years as a special needs and mathematics instructor and school administrator, and is currently completing doctoral work in evaluation at MSU.

Budget

See draft budget in narrative budget section on Fastlane.