

COLLEGE OF SAN MATEO MATHEMATICS AND SCIENCE TEACHER EDUCATION PROGRAM: A BAY AREA COLLABORATIVE FOR EXCELLENCE IN TEACHER PREPARATION WITH SAN JOSE STATE UNIVERSITY AND SAN FRANCISCO STATE UNIVERSITY

C. TONINI

College of San Mateo, San Mateo, CA 94402

The College of San Mateo (CSM), a community college serving the San Mateo County area of California, is part of a collaborative effort in the San Francisco Bay Area to improve mathematics and science teacher preparation. With funding mainly through the National Science Foundation, the project is locally referred to as the MASTEP Project (Math and Science Teacher Education Program). MASTEP partners include two California State Universities (San Jose State University and San Francisco State University), four community colleges (College of San Mateo, City College of San Francisco, Evergreen Valley Community College, and San Jose City College), selected K-12 schools, and a number of informal educational institutions and local industries. Activities at CSM include recruitment of future math and science teachers through an active future teachers club; tutoring, mentoring and advising through the activities of an integrated science center; and professional development activities and financial support for science and math faculty resulting in their significant involvement in curriculum reform. As a community college, CSM plays a major role in identifying and supporting future teachers and providing these students with courses that are models of effective teaching.

The Bay Area Demographics

California presently educates 11% of the nation's children and the California State University system (CSU) credentials 75% of the state's elementary and secondary teachers. The service area of the Bay Area collaborative has a population of 3.5 million and educates 11% of California K-12 students. The school districts from San Francisco, San Mateo and Santa Clara counties include a wide range of urban, suburban and rural schools with very diverse ethnic compositions and a total K-12 enrollment of 388,000. Santa Clara County has over 60% non-white students, San Francisco County has 87% non-white students, and San Mateo County has 58% non-white students. As points of comparison, at San Jose State University for the period of 1992-1996, only 19.4% of students receiving a secondary science credential were non-white and 18.6% of students receiving a secondary math credential were non-white [1]. San Francisco State University has a similar enrollment pattern. The College of San Mateo is centrally located between the two California State University campuses and

acts as a major feeder of students to San Francisco State University, San Jose State University, and other baccalaureate institutions.

The College of San Mateo is part of the San Mateo County Community College District. The area served by the college is in the midpeninsula from Redwood City in the South to South San Francisco in the North. The District also includes Canada College in the South and Skyline College in the North. Total enrollment at CSM for Fall 1997 was 11,687. District statistics for the College of San Mateo show the following percentages for ethnic enrollment for Fall 1997: Asian 19.3%; African American 3.5%; Filipino 6.8%; Hispanic 15.7%; Native American 0.6%; White 48.8%; Other/Unknown 5.3% [2]. According to the County Office of Education, the ethnic composition in K-12 feeder school districts reflect the diversity of the communities that they serve and the majority of students in San Mateo County public school districts are from ethnic minority groups [3]. Overall, the Bay Area suffers from a critical shortage of qualified math and science teachers and the teaching workforce does not represent the cultural and ethnic diversity of the surrounding communities.

Approximately 70% of San Francisco State University and San Jose State University students are transfer students from the California Community College system which is the largest feeder of underrepresented students to baccalaureate institutions [4]. Thus, the MASTEP model includes the active participation of the four major feeder community colleges with the two local State Universities.

Overview of the MASTEP Model

The MASTEP model for the Bay Area is a multifaceted project that includes a number of activities at both the community college level and the university level. Major components of the overall project include 1) **recruitment**, 2) **reform of content and teaching**, and 3) **new teacher support**. The community colleges' involvement in the first two components is extensive.

The goal of the recruitment effort is to identify and attract more students into science and mathematics teaching at K-12 levels, especially those from underrepresented groups. Since the community college is a rich source of ethnic diversity and talents, we play a major role in

the recruitment effort.

The reform of college content and teaching is a component directed to science and math faculty, including the community college faculty. Major elements of the component include: a) a math and science faculty development program, b) formation of collaborative faculty groups to address teaching and learning issues and c) financial support for faculty to engage in developing course enhancements (new teaching approaches, new materials, technological applications) and for designing and implementing science and math courses and curriculum revisions. The goal of this component is to support faculty in exploring and introducing new and more effective methods of instruction in key courses that are taken by future teachers.

The third component of MASTEP, new teacher support, is instituted by the two state universities in the collaborative. All new science and math teachers are currently teamed up with experienced mentor teachers in the community.

The California Model for Teacher Certification and MASTEP

In California, a baccalaureate degree in an academic major is a prerequisite to earning an elementary or secondary teaching credential. Professional education preparation is deferred to a "fifth-year" credential program. As a result, during the undergraduate years, there is a separation of subject matter coursework from professional preparation. Traditionally there have been no teaching-oriented enrichment activities in future teachers' undergraduate background. Further, most science and math faculty have relegated instruction in pedagogy to their colleagues in science education and math education, who, in general, only impact students during the "fifth" year of credential coursework.

The MASTEP model concurs with the current reform movement as expressed by the AAAS [5] and the National Research Council [6] that it is the responsibility of science and math faculty to model how to teach their disciplines effectively. Since the majority of the students that enter the credential program spend their lower division years in community college introductory and core sequences, these courses are critical in setting the intellectual tone for future teachers. Traditionally, most teachers teach the way they were taught. Courses at the community college must be models of effective instruction, not only to better

serve the learning needs of the community college student, but also to provide models of instruction for future teachers.

Before a campus and faculty can achieve this goal they need to learn how students learn. The approach adopted by MASTEP and the collaborating colleges has been to devote the first two semesters of the project to workshops and seminars in teaching and learning before supporting faculty to undertake curriculum revisions. In addition to learning new modes of instruction and assessment, including the use of new technologies, the college faculty during this time period has formed course development teams that includes cross campus groups and K-12 participation.

The Role of the Community College in the Collaborative efforts of MASTEP

In the last two years, CSM has formally been involved in the MASTEP project with San Jose State University and San Francisco State University. The activities at CSM cover a number of aspects of the MASTEP model, including recruitment of future math and science teachers through an active future teachers' club; tutoring, mentoring and advising future teachers through the activities of an integrated science center; early field experiences for students through a science outreach program; and an extensive teaching and learning component that provides professional development workshops for science and math faculty resulting in their significant involvement in curriculum reform and the revision of core science and math courses.

The general goals of the College of San Mateo as a community college work synergistically with the goals of MASTEP. A major goal of CSM is to assist students to become self-regulated learners. To achieve this goal faculty have re-examined their teaching strategies in light of recent findings in learning. This re-examination has produced a shift of the teaching-learning paradigm. The new paradigm focuses on learners, holding them responsible for their learning and de-emphasizes the role of the teacher as the "dispenser of knowledge". The instructor assumes the role of "coordinating" and guiding the learning process. In this role, the instructor organizes group instruction, inquiry based laboratory investigations, collaborative learning experiences and offers to the learners resources that allow for different learning styles.

Assessment has also been re-examined. One major goal is to ascertain how well particular teaching strategies and technologies assist learners to acquire higher order skills such as the ability to communicate effectively, the ability to think critically and the ability to analyze data and synthesize new knowledge. Another major goal is to document the effect of the new teaching paradigm on the students' affective outcomes, such as willingness to participate in the learning process, preparedness to receive instruction, commitment to excellence, valuing and understanding the material learned, and using it with competence later when needed.

Reform of Content and Teaching

Revision of the Undergraduate Curriculum for Future Teachers

The Math and Science Division at College of San Mateo has been actively involved in curriculum reform for the past three years. Both math and science faculty have been introducing curriculum improvements directed at introducing new and more effective methods of instruction in key courses that are taken by future teachers. These efforts have been recognized by the local State universities and have resulted in a formal partnership for curriculum and professional development.

Current course areas at the College of San Mateo that are being revised through the MASTEP project include physics and general biology. The physics project entitled *Improving Math and Study Skills in Required Physics Sequences for Science Majors* will result in the creation of a preparatory physics course. The course development was prompted by the commonly high attrition rates and low student skill levels found in most physics courses, including those taken by future teachers. The faculty curriculum revision team not only includes three instructors from the College of San Mateo, but also the active participation of the physics department at San Francisco State University and San Francisco City College.

There is also a number of in-house funded reform initiatives related to the physics project. A project entitled *Integrating Computers into Physics, Astronomy, and Geology Laboratories* is a collaborative effort of an interdisciplinary team of physical science instructors to further supplement current teaching methods with multimedia and computer applications. This project is allowing student and faculty the use of technologies that apply the results of new learning theory research by creating opportunities for active investigation.

A second collaborative team that includes faculty from San Jose State University, CSM, and a local high school is involved in the development of multimedia modules for general biology. The modules will be used to supplement lectures for human biology and general biology courses at the lower division level. The goal is that through use of the modules, students will more readily comprehend abstract concepts in biology. The faculty development team has done extensive research and networking to ensure a strong pedagogical basis for the modules.

The College of San Mateo also has a math reform curriculum revision team. The team is in the process of redesigning curriculum and establishing a computer based mathematics classroom. In the *Discovering Mathematics With In-Class Computers* laboratory students use software actively and collaboratively to explore concepts as they occur in instruction, to perform arduous computations and to produce graphs and numerical tables quickly. Students work on real-world, open-ended problems, often collecting their own data. The intent is that students will view and practice mathematics as an experimental science in which concepts are established through a process of gathering data, building conjectures, then testing the conjectures. The classroom and curriculum has also been made available to high school mathematics instructors through professional development activities.

Another related educational reform initiative underway at CSM is the *Geographic and Environmental Information for Education Project (GENIE)*. This project includes a development team of both faculty and students from mathematics, physical and life sciences, social and political sciences, statistics and urban planning. GENIE is actually a set of related projects that allows students real world, hands-on training in manipulating data acquired through remote-sensing techniques. Goals of the project include implementing remote-sensing data use in a broad range of community college courses, creating curriculum modules and courses that are transportable to other community colleges via the World Wide Web, and establishing a WWW server that will be an ongoing source of data and curriculum materials to other community colleges and universities. Teacher training materials related to the GENIE project will be developed through the collaborative efforts of CSM and the National Aeronautics and Space Administration (NASA) Office of Human Resources and Education.

Faculty Development Program

As these various curriculum revision projects continue their efforts, the curriculum development teams continue to attend conferences and workshops on teaching and learning in a continued effort to explore improved methodologies for teaching science and math. MASTEP sponsored workshops have included presentations by Dr. Bruce Alberts of the National Academy of Sciences, Dr. Marion Diamond, Director of the Lawrence Hall of Science, Dr. Roger Johnson of the Cooperative Learning Center of the University Minnesota, and representatives from Project 2061. Team members have also had the opportunity to attend one- to three-week workshops on multimedia development and technology mediated instruction. A number of faculty members have also attended residential summer workshops on various topics related to their projects. Through these efforts the College of San Mateo can better assure that future math and science teachers will experience models of effective curriculum and teaching.

Recruitment and Support of Future Teachers

Formation of a Future Teachers Club

As part of the recruitment and support effort for future teachers the College of San Mateo has formed a Future Teachers Club whose goal is to attract talented and diversified students into science and math teaching from the undergraduate pool at CSM. The club offers a number of benefits and activities for participants including field trips to informal educational institutions, tours to transferring universities, participation in model activities demonstrating effective teaching methods for grades K-12, assistance with the transfer and admission process into a four-year college, and assistance with scholarships, summer internships, and other financial opportunities to continue their education.

Opportunities for Early Field Experiences

Students are also given the opportunity for field experiences in K-12 classrooms through the Science Outreach Program. The College of San Mateo has an agreement with its "sister" elementary school that gives interested students the chance to work with the science resource specialist and elementary classroom teacher to design and present lessons in the elementary classroom. This component of the project has been supported by the Trustees' Program

Development Funds of the San Mateo County Community College District.

Support through the Integrated Science Center

Three years ago representatives from both the physical sciences and life sciences joined efforts to form the Integrated Science Center (ISC) at CSM. This center provides tutoring for students and is actively involved in curriculum revision projects that demonstrate the integrated nature of science and science teaching. Through the Center students who are interested in teaching are encouraged to work with faculty on curriculum improvement projects. The Center includes several high-end multimedia development stations that facilitate collaborative work by both faculty and students on developing multi-media instruction. This experience exposes future science and math teachers to emerging multi-media techniques in a very supportive environment. It also provides tutoring, personal support and academic advising for future teachers. The Future Teachers Club activities are also based in the Center.

Establishing an Educational Network

The MASTEP project at CSM emphasizes the formation of educational networks between K-12 teachers, industry and informal educational institutions in the Bay Area. A number of CSM math and science faculty serve on local K-12 curriculum committees. The College of San Mateo has hosted professional development activities and workshops for science and math faculty from local high schools.

Networking efforts are also taking place with Joint Ventures, a Silicon Valley Network which is a collaborative effort of local businesses, government entities, and K-12 schools to ensure that all students in the Silicon Valley attain world-class standards in literacy, mathematics, science, critical thinking and communication skills. Two school teams that are feeder schools to the college of San Mateo have been formed by Joint Ventures. Each team includes a high school and its feeder elementary schools. The Math/Science Division of the College of San Mateo is communicating with these school teams and looks forward to future collaborative efforts.

Evaluation

A major component of MASTEP is the continual evaluation of project activities to provide formative feedback to all persons involved in the various aspects of the project. The purpose of the evaluations is to determine the extent to which major goals of the project are achieved. Planning and implementation of specific evaluation procedures of project components funded by the National Science Foundation are directed by consultants from Far West Laboratory/WestEd in San Francisco.

The evaluation is focused along two lines of work: 1) a quantitative strand with data on specific indicators and 2) a qualitative strand consisting of case studies of the major components of the project. The following questions will be answered for the various project components that are being implemented at the community college level:

Teaching and Learning Component

- How have project activities impacted the practices of instructors of college entry-level math and science courses?
- Which project strategies are most successful in facilitating change in content and teaching of targeted college level math and science courses?
- What have participants learned that they value?
- What have participants learned that they can and do apply to their own instruction?

These questions are being answered by some of the following methods: interviews and surveys of students and instructors; faculty self-rating instruments and logs, attendance and participant feedback on project activities; documentation of changes to syllabi, classroom activities, and student assessment; and enrollment data on targeted courses.

Recruitment Component

- Is the MASTEP outreach program successful in recruiting increased numbers of potential math and science teachers, particularly among underrepresented minorities?
- How has the project impacted attitudes towards teaching as a career on the part of high school and college students?
- Which of the project strategies are the most successful for recruiting increased numbers of math and science teachers?

These questions are being answered by the following methods: attitude inventories,

enrollment data, demographic data, interviews with students and teachers, evaluation forms of specific project events/activities, and case studies.

Indicators of success for each component have also been identified. During the next three years the formative assessments of the project components will allow us to decide which components of MASTEP are successful enough to institutionalize. After this determination is made, the college will seek to reallocate internal resources and, where necessary, pursue external funding to continue those components that need to be retained but which are not currently receiving support directly from the college.

Through MASTEP, the Integrated Science Center, the Science Outreach Program and the Future Teachers Club, the College of San Mateo is taking a leadership position to make a lasting, dynamic impact on science and mathematics education in the Bay area. ■

References

- [1] *Enrollment Statistics for Selected Math Education and Science Education Courses*, San Jose State University of Institution Research, 1992-1995.
- [2] *San Mateo County Community College District, Fall 97 Full Time Students-Selected Characteristics*, San Mateo County Community College District Research Council, 1997.
- [3] *Enrollment Trends, Diversity, and Performance Indicators in San Mateo County K-12 Public Schools*, The SMCCCD Research Council, 1997.
- [4] *San Jose State University and San Francisco State University Perspectives, Student Census*, Office of Institutional Research.
- [5] *Science for All Americans*, American Association for the Advancement of Science, Washington DC, 1989.
- [6] *Fulfilling the Promise: Biology Education in the Nation's Schools*, National Research Council, Washington DC, 1990.