

Strategic Programs For Innovations In Undergraduate Physics At Two Year Colleges

A Project of The American Association Of Physics Teachers

A Case Study

Estrella Mountain Community College Avondale, Arizona

Institutional Setting

Opened in the Fall 1992, Estrella Mountain Community College (EMCC) in Avondale, Arizona, the newest of eleven campuses in the Maricopa County Community College District, provides educational opportunities and workforce training for western metropolitan Phoenix. EMCC is a public institution serving a student population of 7000 students, 85% of which are part time students. EMCC offers numerous associate degrees, university transfer partnerships and 17 specialized certificate programs. The college is a Hispanic serving institution with 37% of the enrollment comprising minorities and 57% female. Estrella Mountain CC is funded through the Maricopa County Community College District that draws 60% of its support from property taxes. The two year colleges in Arizona are no longer governed by a state coordinating board; thereby the MCCD functions independently from the other state community colleges.

Estrella Mountain Community College is located in an area once characterized as rural and sparsely populated. It offers numerous associate degrees, university transfer partnerships and 17 specialized certificate programs. The college's service community is experiencing a rapid growth in population with an increasing need for college prepared young people. Consequently the college is expanding its physical facilities and number of full time faculty to accommodate the increasing enrollment.

The first full time physics faculty at EMCC was hired in 2001. Prior to that time, physics courses were taught by part-time faculty. The physics program, housed within the science and math division at EMCC, has one full time physics faculty. Providing support to the program are a full-time lab technician serving all sciences and an administrative secretary for the science-math division. The program provides seven physics courses (a one semester bridging course for those wanting to be engineers but need some preparation, a one semester physics course for liberal arts majors, a two semester algebra-based course sequence and a three semester calculus-based course sequence) on the EMCC campus and one dual-enrollment class at a local high school. Enrollment on the campus is approximately 55-60 students.

What Has Been Done

1. The EMCC administration successfully conducted a faculty search for an experienced and innovative physics teacher to establish a program providing the array of physics course offerings from conceptual physics through the calculus-based physics course sequence.
2. The physics faculty has successfully implemented teaching innovations into its physics courses. The Modeling Method is the basic methodology for every physics class and the Modeling Discourse Management Method is employed for the management of each class. The physics courses use MBL activities (Vernier Software) either created locally or from *Tools for Scientific Thinking* and *RealTime Physics*.

3. The program successfully recruits and prepares STEM majors for successful transfer to a college/university. Approximately 30 of the students currently enrolled in physics at EMCC (50%) plan to pursue a major in a STEM discipline.
4. The number of non traditional students enrolled in physics averages about 10-15%, which is fairly representative of the non traditional physics student populations among community colleges.
5. The physics program identifies its students who plan to become K-12 teachers and provides, with institutional and divisional support, introductory and preparatory science-math courses for education majors transferring to Arizona State University and Arizona State University West.

Indicators of Success

1. Since the hiring of the full time physics faculty in 2001, class enrollment and offerings have increased each semester. The college now offers the entire range of physics courses provided by the Maricopa County Community College District. In addition many students completing the one semester survey course in physics decide to major in one of the STEM disciplines. A bridging one-semester physics course has been implemented to enhance the preparatory skills of EMCC entering students who plan to pursue studies in STEM disciplines.
2. Student understanding has been measured using standardized assessment instruments such as the Force Concept Inventory (FCI), the Mechanics Baseline Test, the Conceptual Survey of Electricity and Magnetism and the Test of Scientific Reasoning (Lawson). The Force Concept Inventory post-test scores for first semester, calculus based physics have averaged 80% with a normalized gain of 0.69. The post-test average for the first semester algebra-based physics course is 73% with a gain of 0.60. Both of these FCI results are better than the national average. Calculus-based students scored 70.8% on the Mechanics Baseline Test (MBT) and 72% on the Conceptual Survey of Electricity and Magnetism; these scores being high, particularly among TYC students. Students in the conceptual physics course were given the Test of Scientific Reasoning and scored an average of 93% with a mode score of 100%.
3. Seventy-seven per cent of the students enrolled in the algebra-based and calculus-based physics courses are STEM majors and successfully complete the physics studies at EMCC. Retention rate for all physics courses has been greater than 90% over the last three semesters. Anecdotal information indicates that most of these students successfully transfer to a institution. The physics program at EMCC is too new to provide tracking data of its students. The high retention rates, the high gain on standardized assessment instruments and the “buy-in for the innovations” from interviewed students testify to the appropriateness of the selected curriculum and pedagogy.
4. The combination of all the minority physics students at EMCC is approximately 50%, which is double the national average and higher than EMCC’s minority student population. The Hispanic physics student population is nearly 40%, which is five times the national average and larger than the Hispanic student population college wide.
5. Students planning to become K-12 teachers comprise 20% of the physics enrollment at EMCC. The identification of education majors in introductory physics is a pioneering effort among the physics programs at two year colleges. Articulation agreements and collaboration between EMCC and the education departments at Arizona State University and Arizona State

University West facilitate the seamless transfer of education majors from the community college as well has to insure the provision of quality science and physics preparatory courses for these majors.

Keys to Making the Changes

1. *Strong administrative support.* The administration at EMCC is receptive to academic change, initiated at the faculty level, and works cooperatively with its faculty to provide the resources, with internal and external funds, necessary to implement and maintain change. The administration also encourages and supports the development and maintenance of a student pipeline from the local elementary schools through the transfer university. The administration has identified and adheres to its institutional strategic directions and goals for the next five years. Much of the philosophical foundation for the college's strategic planning is based on the findings from the NSF symposium held at EMCC on *Best Practices for Student Achievement in Science, Mathematics, Engineering and Technology in 2-Year Hispanic Serving Institutions*.

The physics program, as one component of the science and math division at EMCC, has evolved slowly and deliberately since the opening of the campus. The establishment of a physics program, with the hiring of a full time physics faculty member, was precipitated by the specified institutional goal to implement an engineering program within the next few years. The search for the full time physics faculty member was also well defined and deliberate. The administration wanted a teacher with demonstrated experience in best teaching practices appropriate to the needs and career goals of the EMCC student body.

The Dean of Instruction allocated the resources for the newly hired full time physics faculty in 2001 to create a microcomputer-based laboratory for all physics classes and will allocate resources to remodel a lab area during the Summer 2003 to better accommodate the Modeling Method innovation used in all physics classes. The Dean has also stated that the college will continue to update the physics program's computer and technology needs on a regular basis.

2. *Innovative Curriculum Appropriate to Student Needs.* The Physics Program offers an innovative approach to teaching introductory physics at all levels. The Modeling Method is an adaptation of the innovations used successfully in many high schools across the country. Students work together cooperatively in small groups and then discuss their conclusions as a whole in one large group, thus "actively engaging" students in the learning process. In addition the physics faculty uses a class management technique, Modeling Discourse Management Method that forces students to take ownership of their learning. Each semester the physics faculty incorporates design projects relevant to everyday life that serve as capstone experiences.

A physics bridging course has been a significant contributor to the program's success in preparing students for academic success in the college level physics courses at EMCC. Minority students comprise about 80% of the enrollment in this course.

3. *Commitment of Physics Faculty to Quality Education.* The physics faculty is committed to providing quality physics education to all students. He is accessible to students and is an effective facilitator in their learning process. In addition he is an active and visible participant within the broader physics and physics education communities.

The physics faculty implemented the Modeling Method because he felt, based on his training and experience in physics education research at Arizona State University, that this technique

best addressed the learning needs and career goals of the diverse student body at EMCC. He is actively involved in professional societies like the American Association of Physics Teachers, the Arizona Section of the AAPT and the Maricopa Area Physics Teachers, connecting him to the broader physics communities. In addition the physics faculty works collaboratively with the Physics Education Research group at Arizona State University and the nation wide Modeling Program.

The physics faculty is also actively engaged in outreach activities at EMCC to increase the number the STEM majors, to increase the enrollment of students from under represented groups and to increase the number of students planning to become K-12 science and math teachers. The physics faculty maintains close ties and partnering activities with the physics faculty at the transfer institution, Arizona State University and local industries. He arranges for his students to visit physics classes and faculty at the transfer university and for representatives from both industry and the transfer universities to visit his students during class time at EMCC.

4. *A Supportive Environment.* Interactions and collaborations among faculty, students, and administration are nurtured by the small size of the campus, the small class enrollments, the integration of physics within the science and math division, and the institutional focus to prepare the EMCC students for success in both their academic studies and career pursuits. The science-math faculty and support services staff affect a community of support for both the physics faculty and the physics students.

Estrella Mountain Community College provides institutional initiatives that strengthen the links between its STEM academic programs and the local schools, the general public, local industries and universities. The NASA Center for Success in Math and Science provides outreach activities to pre-college and college students in its efforts to insure that under represented groups are fully prepared to pursue careers that require mastery in mathematics and science. Several programs, such as the Young Scholars Program, the NASA Summer Academy, and the AMAS Summer Bridge Program, target the recruitment and preparation of entering freshmen from among the under represented populations, thereby helping to enhance the retention of students in academic programs at EMCC. The college has also received an NSF funded CSEMS (Computer Science, Engineering and Mathematics Scholarship) award providing scholarships for students pursuing studies in computer science, engineering and math. Through the Inspire.Teach Program the college in partnership with two transfer institutions, Arizona State University and Arizona State University West, has developed a new science-math template in an effort to better prepare future teachers of science and math.

For more information, contact

Dwain Desbien
Estrella Mountain Community College
3000 North Dysart Road
Avondale, AZ 85323-1000
Dwain.Desbien@emcmail.maricopa.edu