

Strategic Programs For Innovations In Undergraduate Physics At Two Year Colleges

A Project of The American Association Of Physics Teachers

A Case Study Miami-Dade College, Wolfson Campus Miami, Florida

Institutional Setting

The Wolfson campus, one of six campuses comprising the Miami-Dade College (MDCC), annually enrolls approximately 16,000 students, reflecting an increase of 17% in each of the last two years. Located in the heart of the Miami business and government districts a few blocks away from Biscayne Bay, the campus offers 60% of its classes during the day and 40% are offered as evening classes. The campus is easily accessible to students via the city's inexpensive public transportation systems and two parking garages accommodate the commuting students and faculty.

The Wolfson campus provides a wide range of academic and occupational programs utilizing modern facilities and state of the art technology available to all faculty and students. The Emerging Technologies Center of the Americas is available to all faculty for special classes, presentations and conferences. In addition students have access to either of two 200-computer rooms within the Computer Courtyard available during the day and early evening.

Wolfson is distinctly an international campus (53% are U.S. citizens) with many students only recently immigrating to the United States. The student profile for the Miami-Dade campus reveals that 62% of the students are Hispanic, 59% are female and the mean student age is 26.5. Sixty-six percent of the students are from low-income families and only 37% of the enrolled students attend college full time. Seventy-eight percent of the students report that they work while attending college; 27% indicate that they work full time.

The physics program is part of the Natural Sciences, Health and Wellness Department, which includes chemistry (3 full time professors), biology (5 full time professors) and general education science programs (4 full time professors). The physics program consists of one full time physics faculty, Dr. Henry Diaz, who has taught at the college since 1976 and holds a physics Ph.D. from the University of Miami; one part time physics laboratory assistant, 3-5 part time physics instructors and one full time laboratory technician serving the laboratory needs of all sciences. Dr. Guillermina Damas, the department chair, was a full time physics faculty at the North Campus of Miami-Dade before transferring to Wolfson campus five years ago. She is active in physics curriculum development and student recruitment and teaches one or two physics courses each year. Like the students at Wolfson, many of the physics faculty and staff are from typically underrepresented groups and some of the part time physics faculty are recent immigrants. Physics students have access to daily tutoring services provided by the Natural Sciences Tutoring Lab (the CHESS lab) open from 8 AM to 7 PM on weekdays and 10 AM to 2 PM on Saturday. The Math Lab is open from 7:30 AM to 9:00 PM Monday through Thursday and 8:00 AM-4:00 PM on Fridays and Saturdays.

The physics program provides a typical range of physics courses including a one-semester introductory astronomy course, two semesters of physics with applications targeting students pursuing health and technical careers, a one-semester basic physics bridging course for students not completing physics in high school, the two semester algebra-based physics sequence and the

two semester calculus based physics sequence designed for science and engineering majors. Each physics course, with the exception of the bridging course, has a separate co requisite one-credit laboratory component. Two physical science courses serve the general education needs of non-technical and non-STEM majors.

What Has Been Done

1. The physics program at the Wolfson campus has successfully incorporated the use of technology and MBL-based pedagogy to facilitate student learning within the physics classes.
2. The campus administration has dedicated a new room for a physics laboratory and classroom. The room has been remodeled according to the specifications of Diaz, Damas, and the laboratory technician, Mr. Arnold Fleisch, producing a state of the art learning environment with full technological capabilities. The room is equipped with 2002-vintage Macintosh computers with the full range of MBL sensors. A computer projection system has been installed accommodating interactive media presentations with interconnected Document camera, DVD and VCR for projection as well as the availability of SmartBoard and Mimeo with both an instructor PC and instructor Macintosh. Recently installed software, the Classroom Performance System, allows faculty to record and instantly analyze student responses.
3. The implemented changes have enhanced the physics instruction at Wolfson with the addition of hands-on experiences and the incorporation of computer simulations of physical problems, motion video analysis, and computerized data acquisition and analysis. The curricular change was implemented to minimize the use of traditional lecture/laboratories, not eliminate this pedagogical venue.
4. In an effort to promote enrollment and retention in the calculus-based physics sequence, the physics program took overt action in 1999 to enforce the prerequisites for these courses. In 2000, the physics faculty developed and offered a one semester bridging course as a prerequisite for students who had not completed high school physics.
5. The Natural Science Department obtained NSF funding for two CSEMS (Computer Science, Engineering, and Mathematics Scholarships) grants in 2000 and 2002. Ten carefully selected faculty from the Natural Science, Math and Computer Science Departments serve as mentors for the CSEMS students. The screening of student candidates was revised prior to the second funding to increase the retention rate of students in the CSEMS program.

Indicators of Success

1. Since 1997, physics enrollment at Wolfson has realized a growth overall, even during periods of time when the college campus was not experiencing growth. In the Fall 1997 the combined enrollment in all courses was 84 and the combined enrollment during the Spring 2002 was 281. During the past two years, the physics enrollment increased about 8%.
2. The physics program at Wolfson has a very strong retention rate among its physics students. For the last three years, each physics course has reported a retention rate greater than 72%. The first semester of the calculus-based sequence, for the last three years, had a 72% retention rate in the lecture portion and a 84.7% retention rate in the lab portion. During this same period of time the second and third semesters in the sequence had 82.3% and 87.5 % retention rates respectively. Both lab portions reported better than 92% retention rates. The courses taught by the Natural Science Department had an average retention rate of 68.2%.

3. The physics enrollment at Wolfson is 38.8 % women, which is higher than the typical community college enrollment of 31% as reported by AIP in 1998 ("Physics in the Two-Year College). Anecdotal data at Wolfson also indicates a higher than normal enrollment in physics from minorities attributed to the campus population comprising 62% Hispanic and 24% African-American.
4. Forty CSEMS scholarships were awarded during the first NSF funding term in 2000. The physics enrollment for the Fall 2001 displayed a marked increase, indicating that the award was serving as a positive recruitment tool for the physics program. Twelve of the CSEMS student graduates will receive scholarships to universities in the Fall 2003. Seventy students received CSEMS scholarships in 2002. Due to improved screening of the candidates for 2002, the physics faculty anticipate that the student performance and retention among these scholarship students will be much higher. The Natural Science Department will submit a third request for NSF funding in 2004.
5. Anecdotal evidence provided by the departmental chair indicates that most students enrolled at Wolfson campus pursuing STEM studies successfully transfer to four year colleges and universities. The calculus-based physics sequence serves as prerequisites for sophomore-level engineering statics and electrical circuits courses. According to the engineering faculty, the campus has a strong reputation for being able to provide university engineering programs with traditionally underrepresented students who are well prepared for the bachelor's engineering programs. The College pre engineering program has articulation agreements with sixty engineering schools across the country, including Georgia Tech and Kettering University.

Keys to Making the Change

1. *Opportunities for Professional Development.* Drs. Damas and Diaz attribute the successful implementation of physics innovations in the classroom and laboratory to the training and support of the leaders of the NSF funded TYC Workshops. These workshops provided the faculty with training in the recent innovations in introductory physics education as well as training in the preparation of writing NSF grants to procure funding to support the change. More importantly these faculty credit the workshops with helping them to realize that the new pedagogy could improve student learning of physics at Wolfson.
2. *Supportive Administration.* The cultural climate institution-wide and within the Natural Science Department fosters academic change. The administration encourages and supports (1) requests for new technology, thus helping the college to provide cutting edge technology skills to its students, (2) requests from faculty to attend professional development activities, (3) faculty in their efforts to procure external funding for programmatic change, and (4) requests for internal resources (financial and physical) to accommodate programmatic changes. As further evidence of the administration's willingness to embrace change, the College, beginning the Fall 2003, will offer a bachelor's degree in physics education, with the main physics component being offered at the Wolfson Campus. This action is the college's response to recent legislation enacted by the State of Florida allowing community colleges to offer bachelor's degrees in secondary education.
3. *Strong Cooperation among STEM Faculty.* The housing of the STEM disciplines within the same department, the enforcement of prerequisites for STEM courses and the shared Natural Science tutoring services foster the strong cooperation among the science and math faculty on the Wolfson campus. In addition, there is strong cooperation among the STEM faculty college-side. In line with the directive from the college president, the six campuses of

MDCC operate as one college and faculty share a responsibility in defining the objectives for the college's academic courses. Dr. Damas has served as the college's convener of natural science faculty. Cross campus communications occur multiple times during the year via face-to-face meetings, teleconferences and email.

4. *Student Friendly Environment.* The Natural Science Department provides a friendly and supportive environment for students. Physics faculty, the lab assistant and tutors spend many hours in the physics classroom/laboratory, making themselves available to the students. A part time lab assistant, in addition to the lab instructor, also works with students as they conduct and complete their lab activities. The network of tutoring centers (the CHESS and Math Labs) located near the physics classroom provide tutoring and peer support as well as providing employment for STEM majors as tutors. Approximately 40-50 students attend the seven or eight annual activities of the science-math club. These club activities include field trips, special speaker presentations and workshops.

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