

CIMAC – A Coordinated Introduction to Mechanics and Calculus

Why this course? A team of math and physics faculty members at Occidental College were disturbed by the “leakage” of intended majors out of math and science courses after the first year of college. We had students who were quite smart, but weakly prepared, who lacked basic math skills and classroom skills, and who often were quite insecure about their abilities. Also, the seeming disconnectedness of physics and calculus, two subjects with a great deal in common, was felt to be part of the problem. Collectively, the faculty examined the problem and devised this new course.

Structure for the Course

- Integration of material from precalculus, calculus and mechanics
- 4 credit course (3 hours plus lab) Fall term, 8 credits (6 hours plus lab) Spring term
 - (equivalent to precalculus + 1st semester calculus + 1st semester physics)
- Team taught by a mathematician and a physicist
- Articulation of clear expectations for the students
- Pre-course assessment of students’ knowledge, skills, and attitudes
- Use of a variety of educational approaches to reach students with different learning styles
- Each day organized around a “Class Format Sheet”
- Outcomes-oriented assessments using a variety of methods
- Incorporation of writing about math and physics as a learning tool
- Regular group exercises and assessments
- Emphasis on hands-on active learning
- Integration of lecture and lab
- Use of technology to explore, understand, and represent concepts
- Attention to student attitudes and confidence as well as knowledge and skills
- Specific support mechanisms

Evidence of Success

- In 4 years, over 2/3 of students enrolled in subsequent math and science courses
- Almost 1/2 of the students pursued a major in math or science
- About 1/4 of students went on to post-graduate education
- Students exit surveys indicate an increase in interest in math and science among the vast majority as a result of taking the course
- Students regularly became help session leaders for the next class – they cited the value of helping others learn for their own learning
- Students show greatly improved communication skills
- Students have greater confidence and willingness to engage in exploration of new areas and discussion of the material
- Students’ performance on the Force Concept Inventory is comparable to standard class

Specific Support Mechanisms Employed in this Course

- o Gateway proficiency checks – 10 question quizzes assessing student skills in very specific mathematical areas, such as factoring, dealing with exponentials and logarithms, dealing with inequalities, ... Students had to pass the entire set of gateways with 90% correct on each. Could take new versions of a Gateway in a specific area as needed until 90% mastery was attained.
- o Upper division student led help sessions – to assist CIMAC students with the Gateway material they were having trouble with
- o Readily available problem solutions – on web
- o Structure for notes through Class Formats – these “outline” handouts helped students organize their class notes, and learn how to take effective notes in a math or science course
- o Regular and timely feedback – students got feedback in class on homework and problems worked in class, they had on-line solutions available, and they were encouraged to access both the Student-led help sessions and faculty office hours
- o Structured opportunities to raise questions – students were regularly asked to submit questions in writing about the material in that day’s class. There were question times built into the class format that students learned to count on as the time to get confusion cleared up
- o Leveraged reworking of exams – students were given the chance to rework exams immediately after they were returned, and given 1/3 of the points they made up
- o User-friendly materials – having a team of faculty from different disciplines developing the course materials eliminated the vast majority of disciplinary jargon, and teased out those assumptions that faculty make unconsciously
- o Emphasis on what is known, not on what is not known – quizzes and exams were designed to find out specifically what students did know and were able to do, rather than targeting the most difficult material. Even exams were scaffolded so students could do some of a problem or question. Exams included problems, short answer questions, interpretation of graphs and other visual representations, and using actual data to draw conclusions
- o Modeling of desired behavior by the faculty – in this team-taught course, one faculty member sat among the students, and participated in the class. That faculty member asked questions as a student might, participated in in-class activities, and generally acted as a guide for the students in the course.

Long term impacts of the course

- All students taking mathematics at Occidental College now take math Gateways – this has spread to a number of other schools
- Faculty involved learned a great deal about teaching and about how to best support students, and changed their teaching approaches permanently
- Evidence was obtained that demonstrated that “regular” students also benefit from structures implemented for weakly prepared students
- Curricular innovations developed for this course were incorporated into “regular” courses
- Faculty who taught in the program incorporated aspects of the class into their other courses
- Many faculty, even outside this course, were convinced that including support mechanisms was not “catering” to the weaknesses of students, but helping them to remedy those weaknesses
- Faculty came to realize that understanding what students do and do not bring to a class, and helping the students to understand this, would produce better learning and student success
- It was demonstrated that much weak student preparation could be mitigated in only 1 year