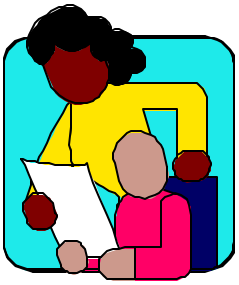

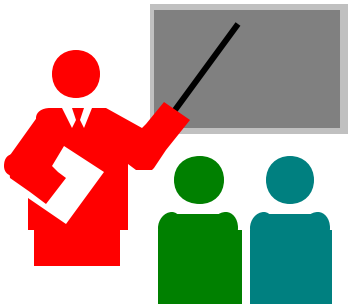

Instructional Techniques

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Instructional Techniques Group Overview

The calculus reform movement called for a shift of focus from teacher-centered to learner-centered in the pedagogical arena and less coverage and greater depth in the content arena. The pedagogical shift involved engaging students in multiple learning activities such as group activities, group projects, discovery work, calculator or computer laboratory sessions, writing assignments, and student presentations. The benefit of each of these learning activities is established in the research literature and each has its own support group of instructors. The difficulties in obtaining widespread adoption lie in the fact that student-learning activities take class time, require more work for the instructor (compared to the lecture format), and require a change in assessment methods. The time factor poses the biggest challenge. The undergraduate teaching profession has been reluctant to reduce content in order to make time for student learning activities and have difficulty accepting that learning is a very inefficient process.

Kathi Snook, group presenter, writes that "Constructivism has been the major guiding philosophical basis for pedagogical change within mathematics classrooms in the last decade." With constructivism as a background she discusses nine instructional methods: Questioning/Discussion, Problem Solving, Use of Technology, Exploration and Discovery, Multiple Representation, Writing, Multiple Assessment Instruments, Section Size, and Use of Group Work.

Bill Haver provides a historical account of calculus reform and the implications for the immediate future. He describes similar reform efforts presently taking place in physics and engineering and notes that lack of interdisciplinary communication has hindered all three reform efforts.

Liz Teles describes the three top educational achievements recognized by the National Science Foundation's Division of Undergraduate Education during the 20th century:

1. Paradigm shift from teacher-centered to learner-centered education.
2. Recognition of the need to balance learning of facts and learning of process.
3. Exploitation of technology for teaching and learning.

She notes the parallel pedagogical recommendations of the American Mathematical Association of Two-Year Colleges, the calculus reform movement, and science, and then addresses the implementation question.

Lida Barrett describes content, curriculum, appropriate administrative framework, and consideration of faculty time and department budget as four areas of fundamental concern in implementing an interdisciplinary calculus course.

David Arney places the introduction of new courses into a core mathematics program into a historical prospective by describing the evolution of core mathematics over the past two hundred years. He argues that new courses follow the development of new science. For example, calculus entered the core program in the mid-eighteen eighties to support

the emerging physics based engineering. Another example is probability and statistics which became part of the core program in the mid-nineteen nineties to support the new science of operations research that developed during World War II. He proposes that a new course, discrete dynamical systems, be included in core programs to support the presently developing new science of information science and complexity theory. He also writes about using mathematics to enhance and teach creativity.