STUDENT PERFORMANCE AND FACULTY DEVELOPMENT IN SCALE-UP ENGINEERING MECHANICS AND MATH COURSES

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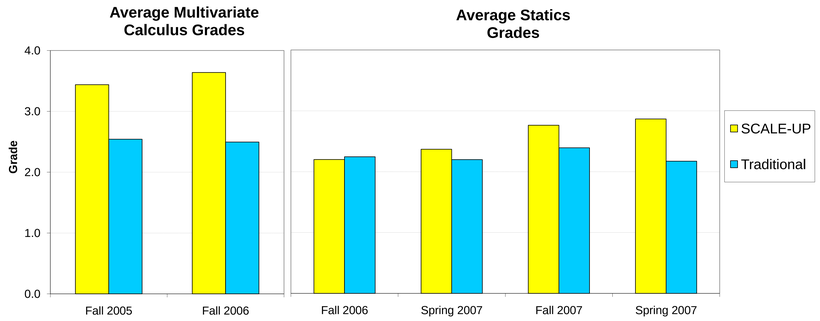
Introduction

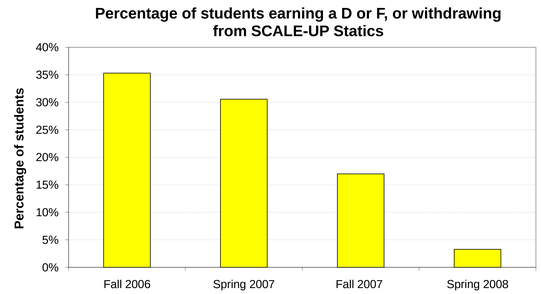
We are in the third year of implementing active and collaborative learning in engineering mechanics and mathematics courses. This approach is modeled after Beichner and colleagues' Student-Centered Activities for Large Enrollment Undergraduate Programs (SCALE-UP) method. An integrated statics and dynamics course for Mechanical Engineers, one section of statics for other engineering disciplines, and a simultaneous multivariable calculus course were taught using the adapted SCALE-UP method. Although the approach has been studied in physics courses (Beichner et al, 2000), it has not been validated in engineering courses. We document the success of the SCALE-UP model in these courses. We also address the professional development needs of instructors to deliver student-centered course materials effectively, through workshops and course support materials.

Improved Student Performance



In addition to course grades, improvements in conceptual understanding of topics have been demonstrated based on gains in student scores on Statics Concept and Dynamics Concept Inventories (Steif et al., 2003) for those taught in SCALE-UP versus traditional methods.

Faculty Development



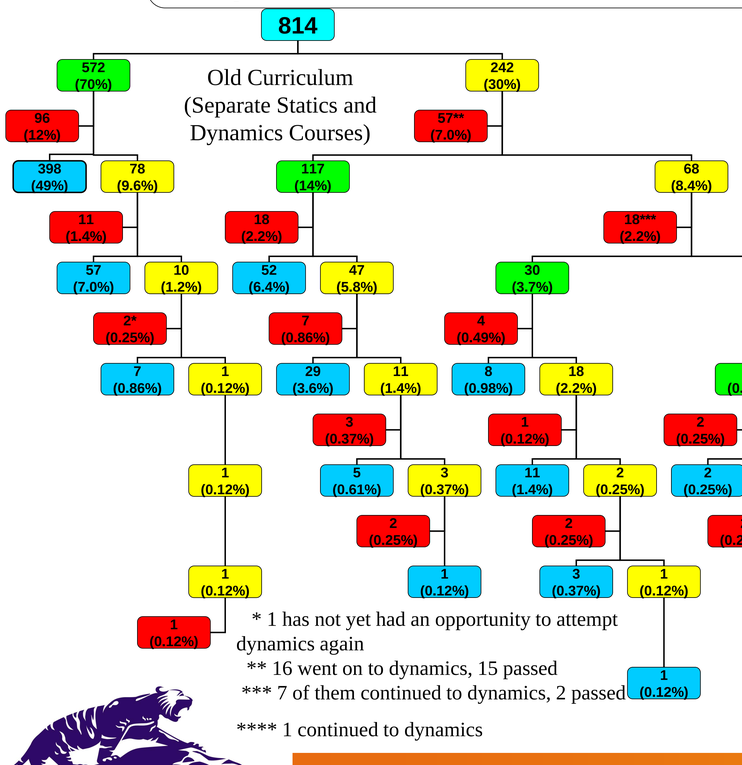
We have observed a consistent drop in the DFW rate for a single instructor over the course of the four semesters teaching in SCALE-UP. This indicates the effects of instructor experience level with teaching in a student-centered format.

We have succeeded in achieving a student-centered learning environment, and in developing course materials that ensure as rigorous a course of study as in a traditional lecture format. The time to develop course materials and innovations is considerable, and may inhibit broader application of this valuable approach to instruction. We seek to streamline this process, thus improving the process of undergraduate STEM education.

Our research team has developed a workshop on adapting SCALE-UP for faculty from all disciplines, engaging participants in a SCALE-UP learning activity that pertains to writing algorithms. Important aspects of the method that were emphasized during the workshop include:

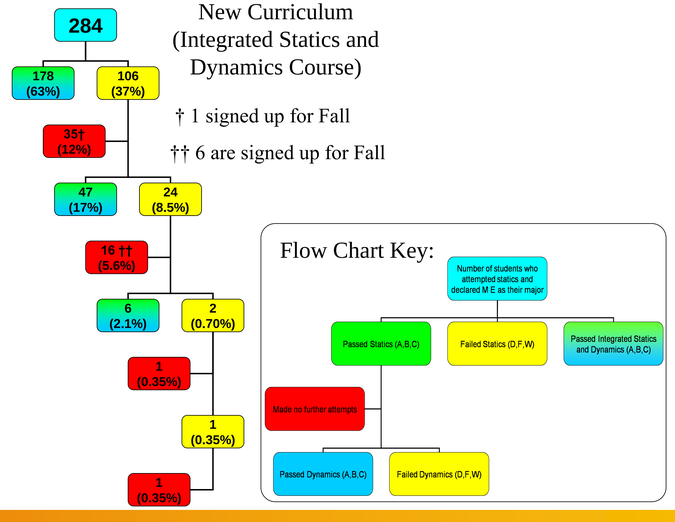
- Student-centered learning; students responsible for mastery
- Mini-lectures interspersed with learning activities
- Learning activities that engage students in learning process
- Learning activities that enable social interactions
- Formative assessments during learning activities
- Infrastructure that enables social interactions

Improved Success and Time to Completion in Mechanics Courses



* 1 has not yet had an opportunity to attempt dynamics again
** 16 went on to dynamics, 15 passed
*** 7 of them continued to dynamics, 2 passed
**** 1 continued to dynamics

Between Fall 2000 and Spring 2007, students who declared ME as their major at the end of their first semester of Statics (old curriculum; 841 students) or integrated Statics/Dynamics (new curriculum; 284 students) were tracked in their progression towards completion of Statics and Dynamics. Of students in the separate course sequence, 49% passed on their first attempts in both; of students in the integrated course, 63% passed on their first attempt. Students in the separate course sequence took 2.48 semesters to complete, with 71% successfully completing both courses. Students in the integrated course finished in 1.26 semesters, with 81% successfully completing it.



† 1 signed up for Fall

†† 6 are signed up for Fall

Future Work

- ❑ Continue tracking student performance in follow-on courses in ME and CE
- ❑ Expand data collection and analysis as more instructors implement the SCALE-UP model in Statics, Dynamics and Multivariable Calculus
- ❑ Compile and analyze results of student and faculty interviews to define elements of successful implementation of student-centered learning in engineering courses.
- ❑ Expand faculty development and training for student learning assistants to improve success of implementation.

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