A STEP to Grow in Science-Engineering-Mathematics Undergraduate Degrees

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Goal

To improve student retention in STEM disciplines, and thus increase the number of graduates in STEM fields, by reforming the curricula of the Engineering and Life Sciences Calculus sequences at USF.

Motivation

- At USF, 6-yr graduation rates are < 60% for STEM majors but > 80% for business, nursing and education majors.
- Passing rates (C or better needed to advance to the next course) average 55% for Engineering Calculus I, II and III and Life Sciences Calculus I and II.
- Students often change their major before even taking a class in it, due to loss of motivation in basic science and math courses and failure to see the relevance to their major.

Thrusts

Project Based Calculus Instruction

- Introduction of "bridge" projects into Engineering Calculus II and III and Life Sciences Calculus II by giving students the option of replacing the final exam with a project.
- Students work with a science faculty member or supervisor in their workplace to define a problem, write and analyze appropriate equations, and write a narrative report – in essence, they write a story problem, and then answer it and write it up as a scientific report

Peer Leading

- Undergraduate peer leaders lead weekly, 50 minute cooperative learning inquiry sessions in Engineering and Life Science Calc. I.
- Curricula developed by faculty and graduate students focus on guiding students to discover concepts of calculus prior to lecture. Algebra and trigonometry warm ups are included.

STEM Mart

- Undergraduate tutors staff a "one-stop" tutoring lab with evening and weekend hours .
- They provide assistance in calculus and in introductory science courses such as chemistry, physics and biology.

Rationale

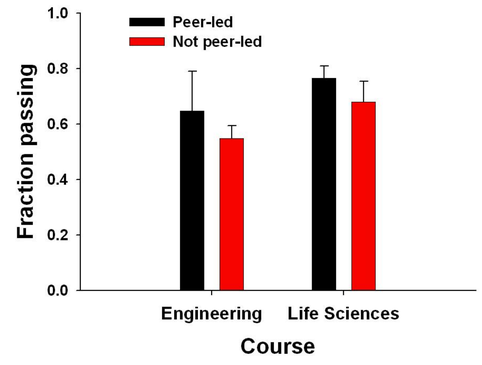
Calculus Passing Rates - 2006

Section	No help session or project	Help session OR project	Help session AND project
Morning	49%	59% (help session)	85%
Evening	45%	67% (projects)	N/A

Focus on Peer Leading

Fall 2008 – Spring 2010

- Fall 2008: A team of a professor, graduate student, and undergraduate in Mathematics attended a chemistry faculty's weekly training session for peer leaders in General Chemistry. This team developed discovery activities for Engineering Calculus I and training materials for peer leaders.
- Spring 2009: First implementation of peer leading in two sections of Engineering Calculus I, with 4 peer leaders, 2 graduate student trainers, and 1 faculty trainer.
- Summer 2009: Revision of classroom activities and training materials. Development of Life Sciences Calculus I discovery activities.
- Fall 2009: Full implementation of peer leading in all 5 Engineering Calculus I and 6 sections of Life Sciences Calculus I, with 18 peer leaders, for 275 Engineering and 180 Life Sciences students. Continuing revision of materials. Data collection for these 11 sections of calculus. See Fig. 1 for initial comparison
- Spring 2010: Beginning data analysis of Fall 2009 grades and the effect of peer leading. Peer leading extended to 12 sections of Life Sciences Calculus I and continues in all 5 sections of Engineering Calculus I. Presently teaching 275 students in Engineering and 312 in Life Sciences Calculus. Recruitment of 2 new peer leaders. Data collection anticipated for the end of the semester.



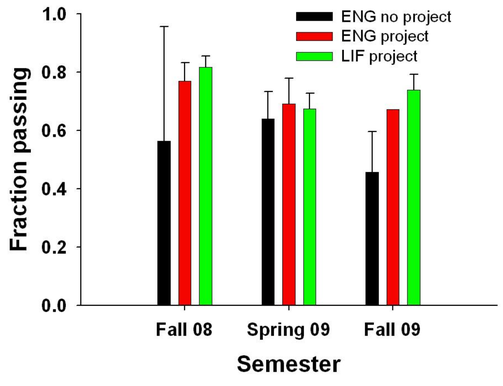


Figure 1. Effect of peer leading (top) and projects (bottom) on passing rates, by class section. Error bars are 95% confidence intervals. The top graph is for Life Science (LIF) Calculus I sections. The bottom graph is for both Engineering (ENG) and Life Science Calculus II sections; all LIF sections offered the project option.

Structure of a Peer-led Activity

- Pre-assignment, which must be completed before class, includes practice with algebra, often a missing skill. At the beginning of every peer-led session, there is a short quiz based on this pre-assignment and the previous week's activity.
- Student group structure: Students work in groups of 4. Each student has a different "role" (manager, recorder, spokesperson, and strategy analyst), and these roles rotate each week.
- Heart of the activity: groups work on discovery activities, structured to include discovery of a concept, concept formulation, and then concept application. The peer leader facilitates classroom discussions and provides support where difficulties occur.
- End of session: students summarize what they have learned and reflect on learning strategies that were or were not effective.

Challenges in the Peer Leading Thrust

- Recruiting enough peer leaders to run all sections of calculus seems difficult.
- Faculty buy-in may be an issue.
- Undergraduate student resistance to innovations in the classroom.

Adjustments in Other Thrusts

- In Fall 2009, STEM Mart was moved to a more centralized location at the library. This move has increased student use of STEM Mart and has made data tracking easier.
- We developed a Wiki for the Life Science Calc II projects and are now expanding it to include all projects and to promote communication among the co-PIs and staff.
- We have initiated our online undergraduate journal. Articles are based on the best projects submitted, in both Engineering and in Life Sciences Calc II.

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