ENGR 107

Application of Mathematics to Engineering



WASHINGTON STATE UNIVERSITY

World Class. Face to Face.

Course Goals

- Primary goal – Prepare students who did not test into calculus and who are eligible for pre-calculus to place into first term calculus based on placement exam
- Secondary goal – Prepare students for mathematics applications in engineering mechanics (statics, dynamics, and mechanics of materials)

WSU Course Offerings

- Summer Term - One of three courses in Summer Advantage Program (21 enrolled)
- Fall Term – Use income from summer offering to fund fall course offering

  (18 enrolled in Fall 2011)
- ENGR 107 Summer Boot Camp – not offered any longer due to low enrollment

Curriculum

- Remove some advanced math applications – differential equations and matrix math
- Remove matlab and add excel
- Add more focus on pre-calculus concepts
  - Exponents, logarithms, etc…
- Conduct practice placement exams

Note: Engr 107 is still not an official prerequisite for Calculus. Many of these changes are because students must still test into calculus. The students have been very successful at this and our hope is that the prerequisite will eventually be granted.

Pedagogical Approach - In-Class Peer Tutors

- Use in-class peer tutors during lecture and lab
  - Active learning improved
  - Abundance of social resources
  - Formative assessment
  - Tutoring and finding that peer tutors make a two sigma difference in learning



Research on Self-Efficacy

- Construct: Mathematics Self-Efficacy (MSE)
  - Definition: A person's *belief* in their ability to successfully perform mathematics
- Higher MSE increases likelihood that students will pursue scientific educational pathways
- Self-Efficacy is best influenced during first college semester

Increasing MSE in students first math course (during primary period of risk) will improve retention

Methodology

- Quantitative
  - MSE Survey, Pre and Post - Two measures – 1) specific courses and 2) specific problems
  - Measure *if* students MSE changed
- Qualitative- Part 1
  - Interviews, Pre and Post
  - Efficacy indicator questions on each
  - Determine *if* students MSE changed
- Qualitative- Part 2
  - Interview transcripts coded to determine *how* students' MSE changed, i.e. what mechanisms in the class influenced MSE change

Results

- Student MSE largely either increased or was maintained
- Students avoided a discouraging first college math experience
- More likely to develop positive MSE beliefs in future courses
- More likely to persist in engineering

Results

- Explanatory mechanisms:
  - Increased MSE:
    - Successful performance on placement test
    - Understanding material
    - Understanding teacher's instruction
    - Correcting misunderstandings from previous classes
    - Prep for calculus: calculus material
    - Understanding homework by use of outside resources
    - Difficult Class Pace
    - Background: lack of recent, relevant math exposure
  - No Change in MSE:
    - Background: student's always excelled at math (likely entered course with already high MSE)
  - Decreased MSE:
    - Misunderstanding class concepts (too far behind)

Development of Math Self Efficacy typical comment

- *David: Um, it was just way to work out problems and make sure I was going to be in the right math course. That gave me a lot of confidence because it sort of proved to me that I don't need to…that I can be in calculus and do well. I can do well in pretty much any math class if I just do the work and stuff. So after that I was certain that calculus was doable, whereas before, I had trouble in high school. But now I'm confident.*

Paper based on the experience with this course

Brown, S., and J. Burnham. (2012), "Engineering Student's Mathematics Self-Efficacy Development in a Freshmen Engineering Mathematics Course," *International Journal of Engineering Education* Vol. 28, No. 1, pp. 113–129

Future Plans

- ENGR 107 offered in Summer ADVANTAGE sessions
- ENGR 107 offered once per academic year (if enrollment is sufficient)
- Negotiate entry into statics (continue to work on a course that is a prerequisite to statics etc.)
- Continuing research on mathematics self-efficacy

Sustainability

- Have partnered with the Summer Advantage program
- Have received general education “quantitative” credit for course. Hence students possibly interested in engineering can take the course and get “quantitative” credit even if they do not go into engineering
- Summer Advantage enrollment financially supports offering the course in the academic year