Engineering 107

Washington State University

ENGR 107 – Engineering Mathematics

- Washington State University Course
  - For students who did not test into calculus and who are eligible for pre-calculus
  - First 10 weeks - Help students qualify for calculus through ALEKS placement exam
    - ALEKS labs and homework assignments
  - Last 5 weeks - Calculus in engineering context

WSU Current Implementation

- Summer 2011 - One of three courses in summer advantage program
- Fall 2011 – Use income from summer offering to fund fall course offering
- Sustainable practice…hopefully

Research on Self-Efficacy

- Construct: Mathematics Self-Efficacy (MSE)
  - Definition: A person's *belief* in their ability to successfully perform mathematics[2]
- Higher MSE increases likelihood that students will pursue scientific educational patheways[3,4]
- Self-Efficacy is best influenced during first college semester[5]
  - Boise State Study[6]: Persistence in Engr. Highly correlated to first math class performance

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

2. Bandura, A. 1997. Self-Efficacy: The exercise of Control. New York: W.H. Freeman and Company.
3. Betz, N.E. and G. Hackett. 1983. The Relationship of Mathematics Self-Efficacy Expectations to the Selection of Science-Based Majors. *Journal of Vocational Behavior* 23: 329-345.

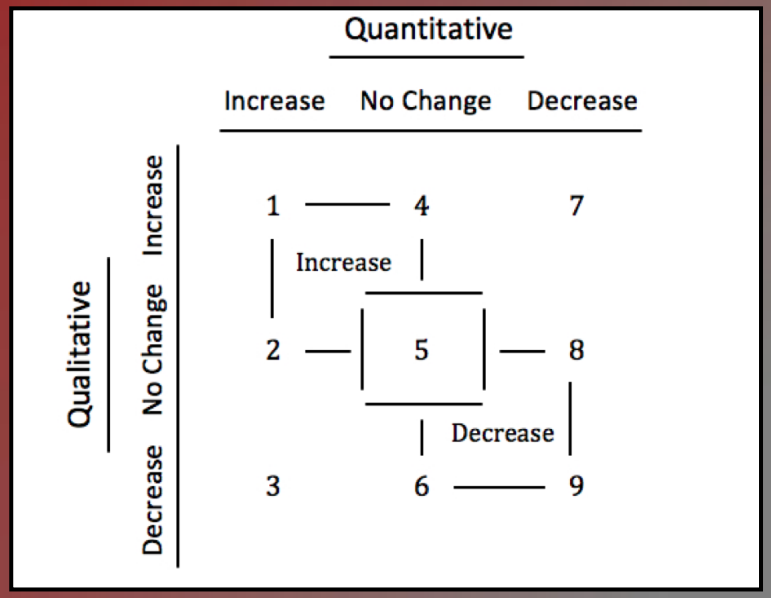
Methodology

- Quantitative
  - MSES Survey, Pre and Post (2 measures – courses and 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
  - Transcripts coded to determine *how* students' MSE changed, i.e. what mechanisms in the class influenced MSE change

4. Lent, R., F. Lopez, and K. Bieschke. 1991. Mathematics Self-Efficacy Sources and Relation to Science-Based Career Choice. *Journal of Counseling Psychology* 38(4): 424-430.
5. Gore, P. 2006. Academic Self-Efficacy as a Predictor of College Outcomes: Two Incremental Validity Studies. *Journal of Career Assessment* 14(1): 92-115.

Methodology Continued

- Students grouped based on changes in efficacy from both quantitative and qualitative methods
  - Influential class-specific mechanisms found for each group based on identified common mechanisms



6. Gardner, J., P. Pyke, M. Belcheir, and C. Schrader. "Testing Our Assumptions: Mathematics Preparation and its Role in Engineering Student Success." Proceedings of the 2007 Annual Conference of the American Society for Engineering Education, 2007-1497.

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

Conclusions

- Student Efficacy Largely Either Increased or was Maintained
- Students avoided a discouraging first college math experience
  - More likely to develop positive MSE beliefs in future courses[2]
  - More Likely to Persist in Engr.
- Similar case studies needed to determine if identified mechanisms can be generalized to produce a working theoretical model to improve student MSE in this setting

Questions?

Extra – Quantitative Results

Table 1- Paired t-test Results

	Math Problem Solving Efficacy Subscale		Math Courses Efficacy Subscale	
	Pre	Post	Pre	Post
Mean Score	7.3	8.0	7.0	7.1
SD	1.0	.66	.90	.89
Coefficient alpha	.85	.90	.58	.77
Significance	Significant at the 0.01 confidence interval		Not Significant	

Table 2 – Quantitative Results

Survey Subscale	**Number of Students**		
	Increase	No Change	Decrease
Math Problem Solving Efficacy	15	10	2
Math Courses Efficacy	5	17	5

Extra – Detecting Qual. Changes

- Multiple questions addressing MSE with regard to ability and future course performance
  - Attention also given to surrounding tone and comments

Table 3-Types of Efficacy Level Responses

	High Efficacy	**Medium Efficacy**	**Low Efficacy**
Math Ability	"I am good at math"	"I am ok at math"	"I am not that good at math"
Future Math Courses Performance	"I feel I will do well in future math classes"	"I am unsure, but I think I will do alright in future math classes"	"I am nervous for how I will do in future math classes"

- Difference in Pre and Post MSE Level to Indicate Change
  - Limited to three levels to preserve external validity
  - Although detecting incremental changes is not possible using this method, those students that did change were considered to have experienced a greater magnitude of change than those who did not