Measuring the Impact of an Individual Course on Students' Success

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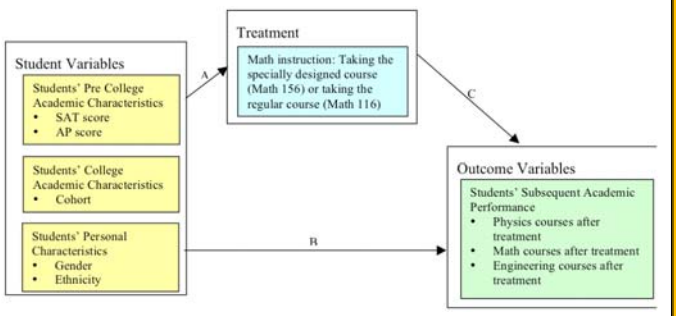
Abstract

Using eight years of institutional longitudinal data we investigated the effects of a special mathematics course on the academic performance of students who did and did not enroll in the course. In spite of the large differences observed in raw measures of achievement, the statistical analysis revealed that after controlling for students' prior characteristics, the effects of the course on students' achievement are not statistically significant. The results point to possible deficiencies inherent in current institutional data for establishing effects of individual courses on students' performance. Our current research designs and data collection processes might not target aspects of instruction that are likely to impact students' academic performance; we suggest possible strategies to address this shortcoming.

Research Question

- Does enrollment in a specially designed course (Applied Honors Calculus II, Math 156) have a positive causal impact on later educational achievement for engineering students at U-M?
- The *model* we use to answer our question is as follows:



Methods

- Context: Math 156 is taught mostly by post-doctoral fellows in small classes, with a lecture approach and a traditional textbook that emphasizes science and engineering applications. Math 116 is taught mostly by GSIs in small classes, with a cooperative learning approach and a reform textbook; applications include science, engineering, and social sciences.
- Sample: All CoE students who took a Calculus II course (Math 156 or Math 116) in the first term of their first year at U-M from the Fall 1997 until Fall 2004 and who were eligible to enroll in Math 156 (their AP score was 4 or 5 in any AP Calculus test).
- Variables (see Model)
- Analyses
  - Regression modeling
  - In case of significant effects, analysis of unobservable variables (e.g., self-selection)

Results

Table 1: Mean and standard deviations for dependent variables by sample and by AP score.

ENGR GPA	891	3.01 (0.70)	762	3.21 (0.66)	172	2.94 (0.73)	273	3.32 (0.68)
MATHGP A	897	2.84 (0.81)	770	3.14 (0.79)	174	2.74 (0.83)	276	3.25 (0.74)

Note: * * All the differences of means between students with AP of 5 and AP of 4 are statistically significantly different from 0 at a < 0.01.

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Table 2: Mean number and standard deviation of post-treatment credits attempted in physics, engineering, and math by group.

	Total Sample N = 2,169			Control Group N = 1,715			Treatment Group N = 454		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
Physics credits attempted	1,776	7.62	3.47	1,415	7.47	3.17	361	8.2**	4.41
Engineering credits attempted	2,098	46.27	23.82	1,653	45.5	23.56	445	49.11**	24.6
Math credits attempted	2,117	10.44	4.16	1,667	10.19	3.90	450	11.40**	4.87

Note: * *. The difference between the number of credits attempted by the treatment group and the control group is statistically significantly different from 0 at $\alpha = 0.01$.

Table 3: Unstandardized regression coefficients for the four outcome variables for students whose AP score is 4 or 5.

	PHYSICS240GRADE (N = 1,481)	PHYSICSGPA (N = 1,776)	ENGRGPA (N = 2,098)	MATHGPA (N = 2,117)
Treatment	0.005	0.047	0.036	0.031
SAT score	0.001**	0.001**	0.001**	0.000**
AP score	0.306**	0.271**	0.194**	0.306**
Female	-0.146**	-0.081*	0.094**	0.159**
Asian	-0.055	-0.083	-0.202**	-0.027
Black	-0.240	-0.483**	-0.516**	-0.418**
Hispanic	-0.246	-0.293**	-0.244**	-0.250*
Cohort2003	-0.330**	-0.199*	0.068	0.026
% of Variance explained by the model (R^2, adj)	8%	9%	7%	6%

Notes: *: The coefficient is statistically different from 0 at an α level of .05. **: The coefficient is statistically different from 0 at an α level of .01. Results were not significant for Native American, Students who did not report their ethnicity, and for the cohorts in 1999-2002, and 2004.

Discussion & Implications

- The treatment (taking Math 156) does not have an impact on later educational achievement of engineering students when measured as grades in the outcomes selected.
- Prior achievement characteristics (such as SAT and score on AP tests) or personal characteristics (such as gender and ethnicity) have a greater impact on the grades.
- Results might be consequence of:
  - Difficulty in controlling for unobservable variables such as self-selection
  - Difficulty in randomizing assignment to conditions
  - Inadequate outcome variables:
    - Inability to measure the differences between the two instructional approaches; are grades good measures of such difference?
- The measures should,
  - Capture instruction: the interaction between teacher and students with the specific content within the particular environment in which each class is conducted.
  - Capture student's ability to solve applied problems.
- It is appropriate to advise students to enroll in Math 156, as other benefits are tangible (e.g., number of credits taken, and some preliminary evidence of good retention in STEM fields).

Acknowledgments

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