WRIGHT STATE UNIVERSITY

A National Model for Engineering Mathematics Education:

Longitudinal Impact at Wright State University

Nathan Klingbeil and Tony Bourne
College of Engineering and Computer Science
Wright State University

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http://www.cecs.wright.edu/engmath/

Motivation and Objective

Motivation:

- The inability of incoming students to advance past the traditional freshman calculus sequence remains a primary cause of attrition in engineering programs across the country.

- Meanwhile, our nation's leaders are calling for 10,000 more engineers per year. We can far exceed this number by simply addressing curricular barriers and graduating more of the students we already have.

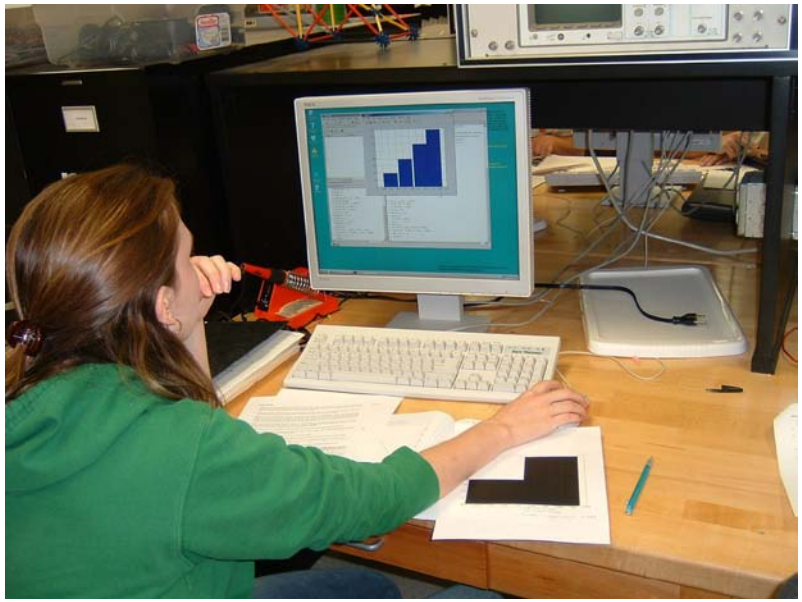


Objective:

To increase student retention, motivation and success in engineering through *application-driven, just-in-time, engineering* math instruction

EGR 101: Introductory Mathematics for Engineering Applications

- Course Topics
  - Linear & Quadratic Equations
  - Trigonometry
  - Vectors and Complex Numbers
  - Sinusoids and Harmonic Signals
  - Systems of Equations and Matrices
  - Basics of Differentiation
  - Basics of Integration
  - Differential Eqns. W/Const. Coeffs.



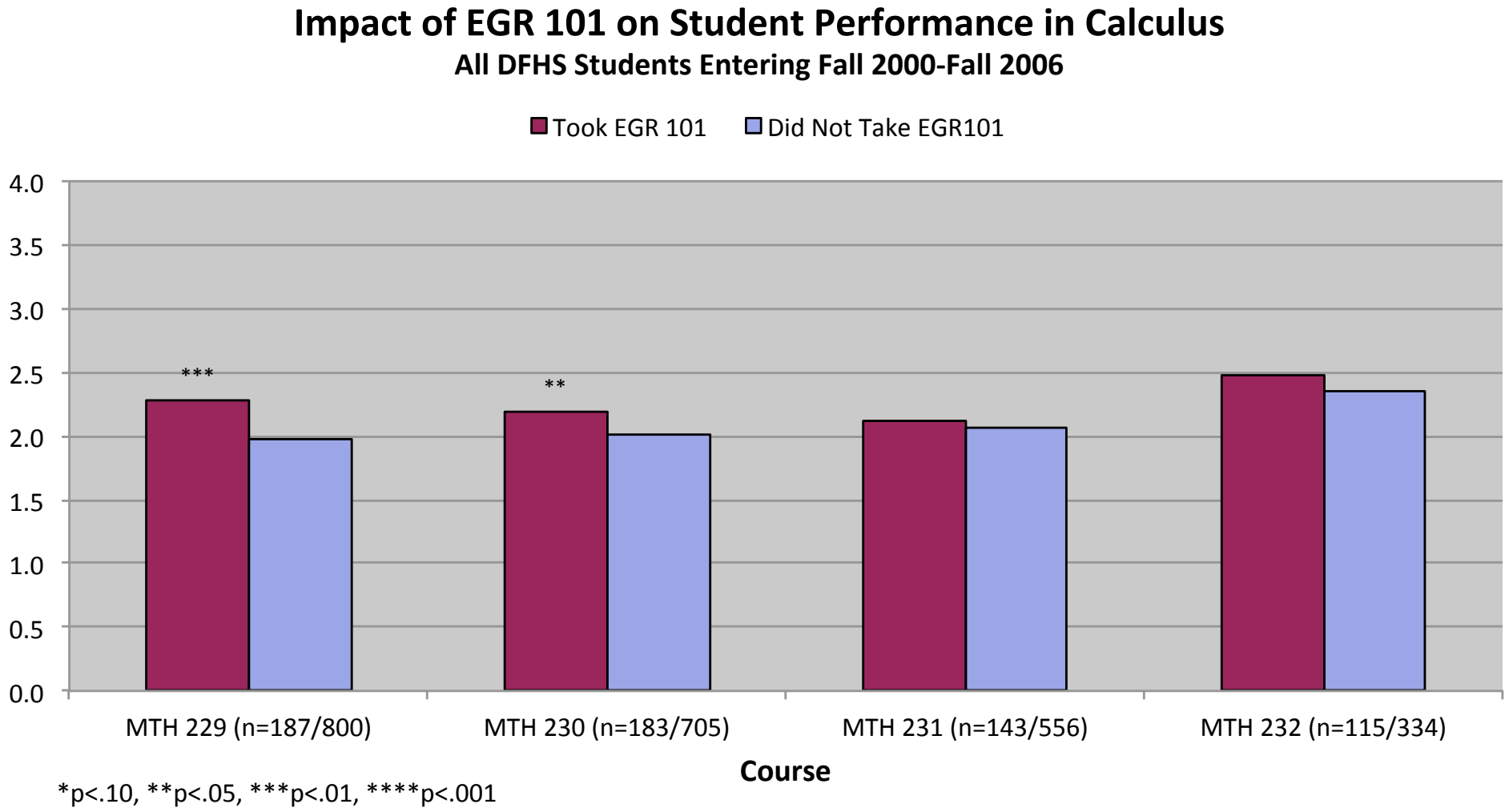


- All topics driven by *engineering applications* taken directly from core engineering courses
- Lectures reinforced by hands-on laboratory and recitation components including a thorough integration with MATLAB
- Replaces traditional math prerequisites for core sophomore-level engineering courses – *effectively uncorking the calculus bottleneck*

Student Comments on EGR 101

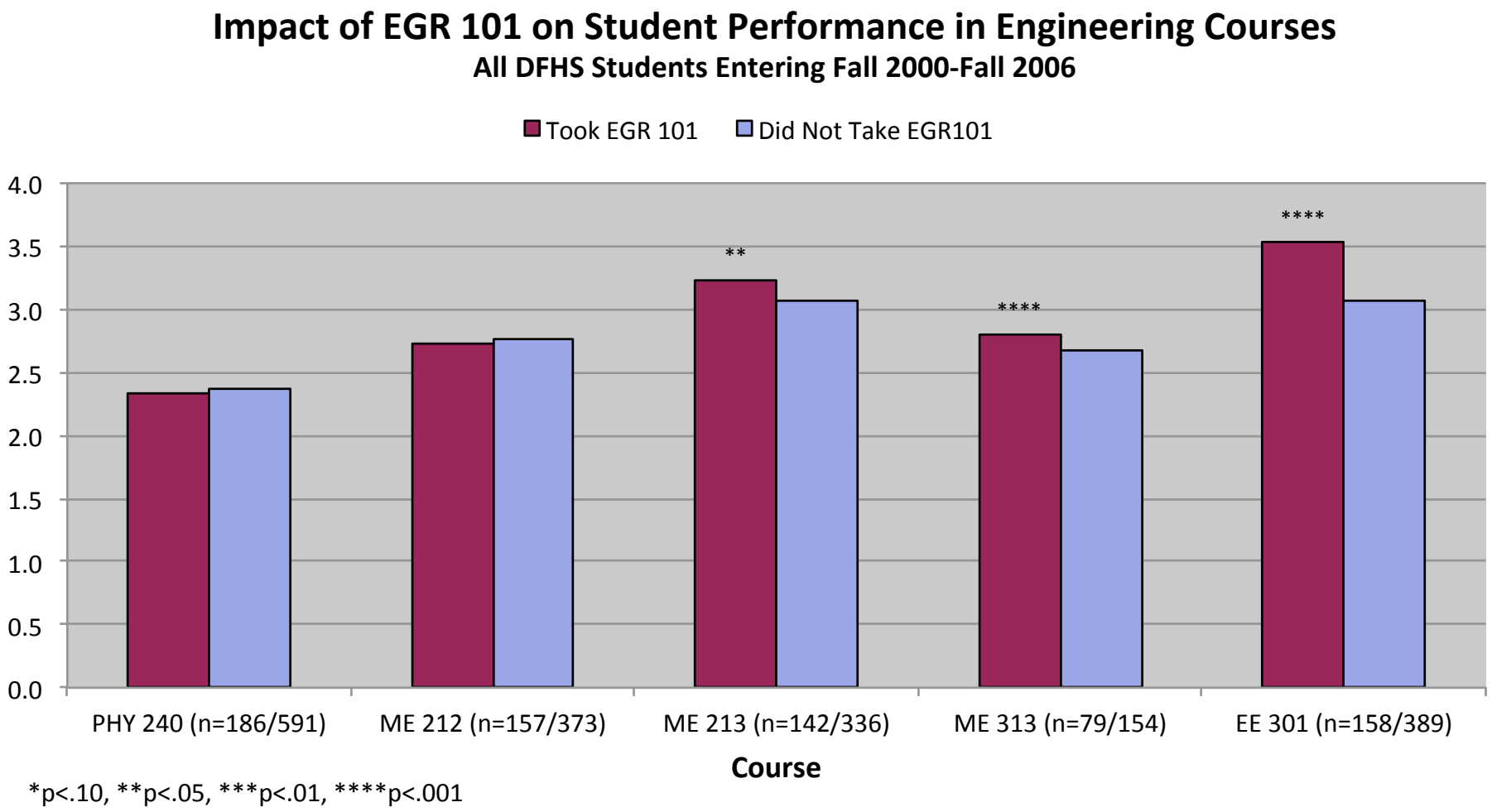
- "This course has really helped me. I was thinking of dropping engineering, but because of this course I am sticking with it…"
- "Being able to put calculus to actual engineering problems helps a lot for me. I didn't understand it in high school, but being able to imagine or see it in an actual problem helped greatly."
- "I enjoyed the class because it focused more on application to real world problems rather than just numbers. The lectures based on example problems followed up by recitation created a very good learning environment for me."

Longitudinal Study: Student Performance in Calculus



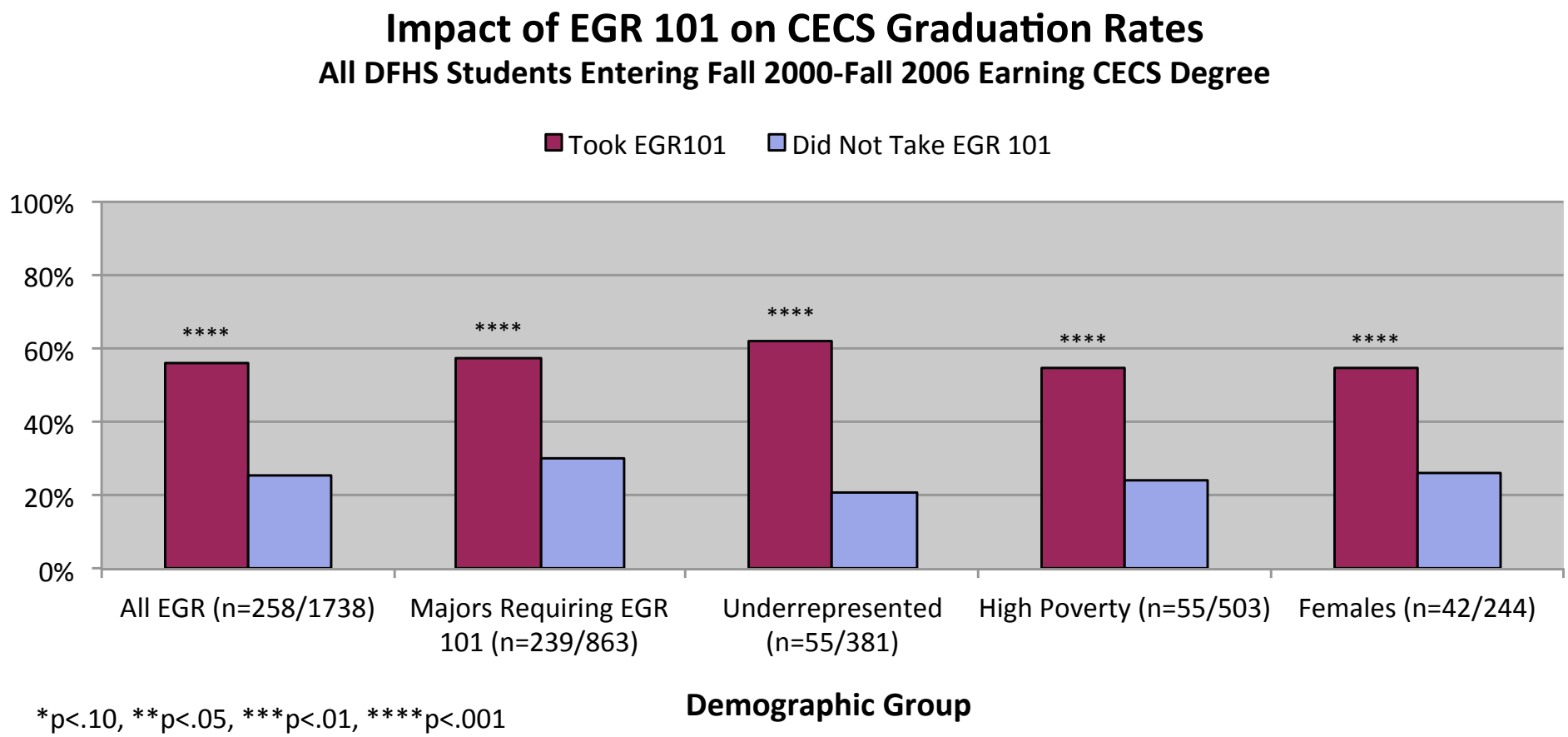
- Students who took EGR 101 had a statistically significant advantage in their first two calculus courses

Longitudinal Study: Student Performance in Engineering



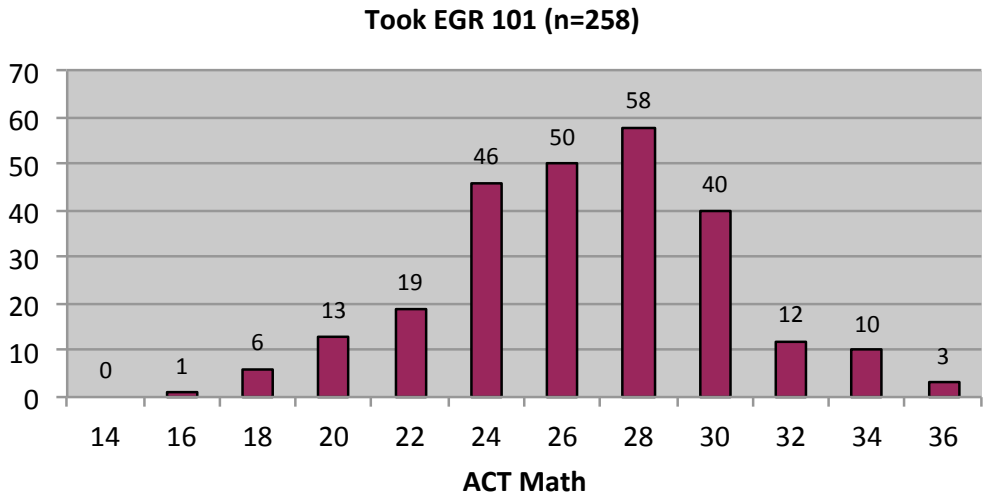
- Students who took EGR 101 had a statistically significant advantage in Dynamics, Strength of Materials and Electric Circuits. No significant difference in Physics I or Statics.

Longitudinal Study: Ultimate Graduation Rates

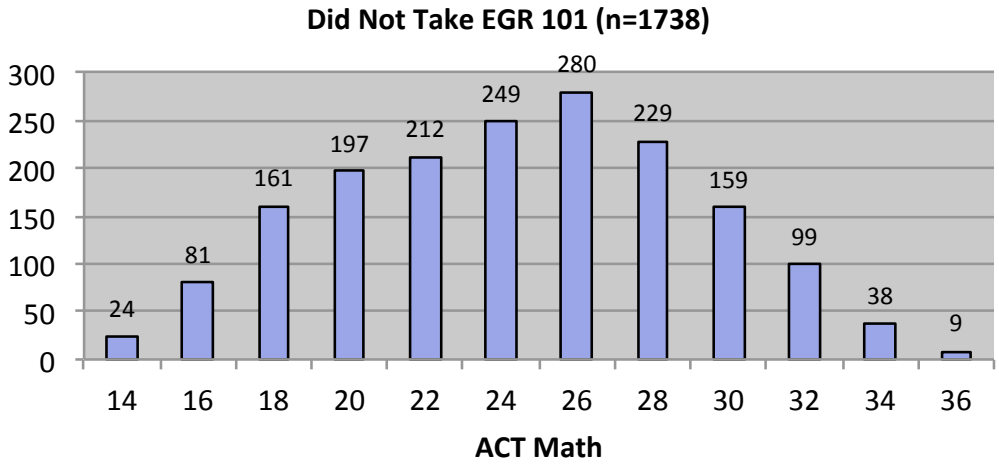


- Students who took EGR 101 earned CECS degrees at more than *double* the rate of those who did not. For underrepresented students, the difference was nearly a factor of *three*…

Longitudinal Study: Are the Populations Comparable?



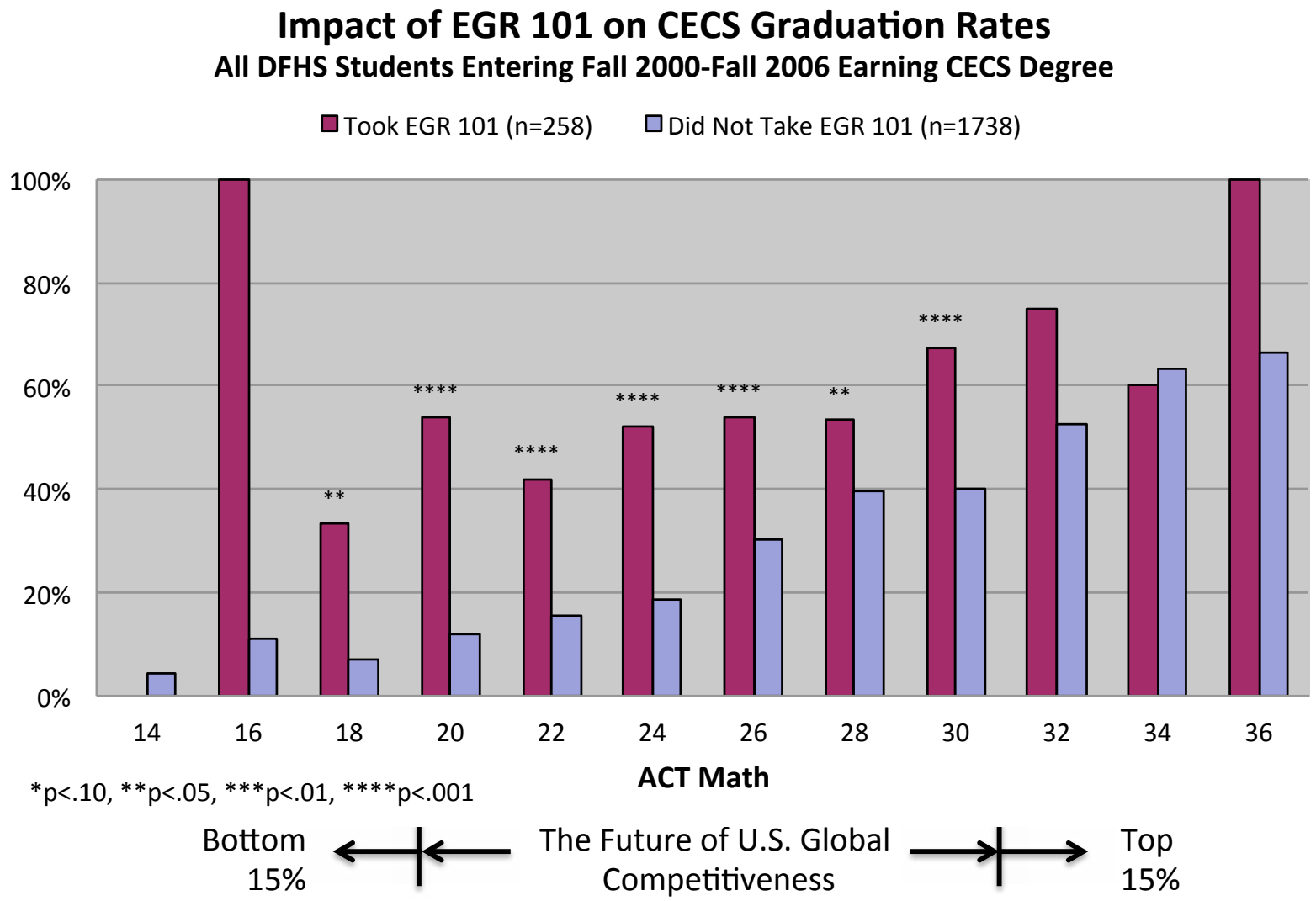
$(\bar{x},\ s_x) = (26.1,\ 3.67)$



$(\bar{x},\ s_x) = (23.9,\ 4.70)$

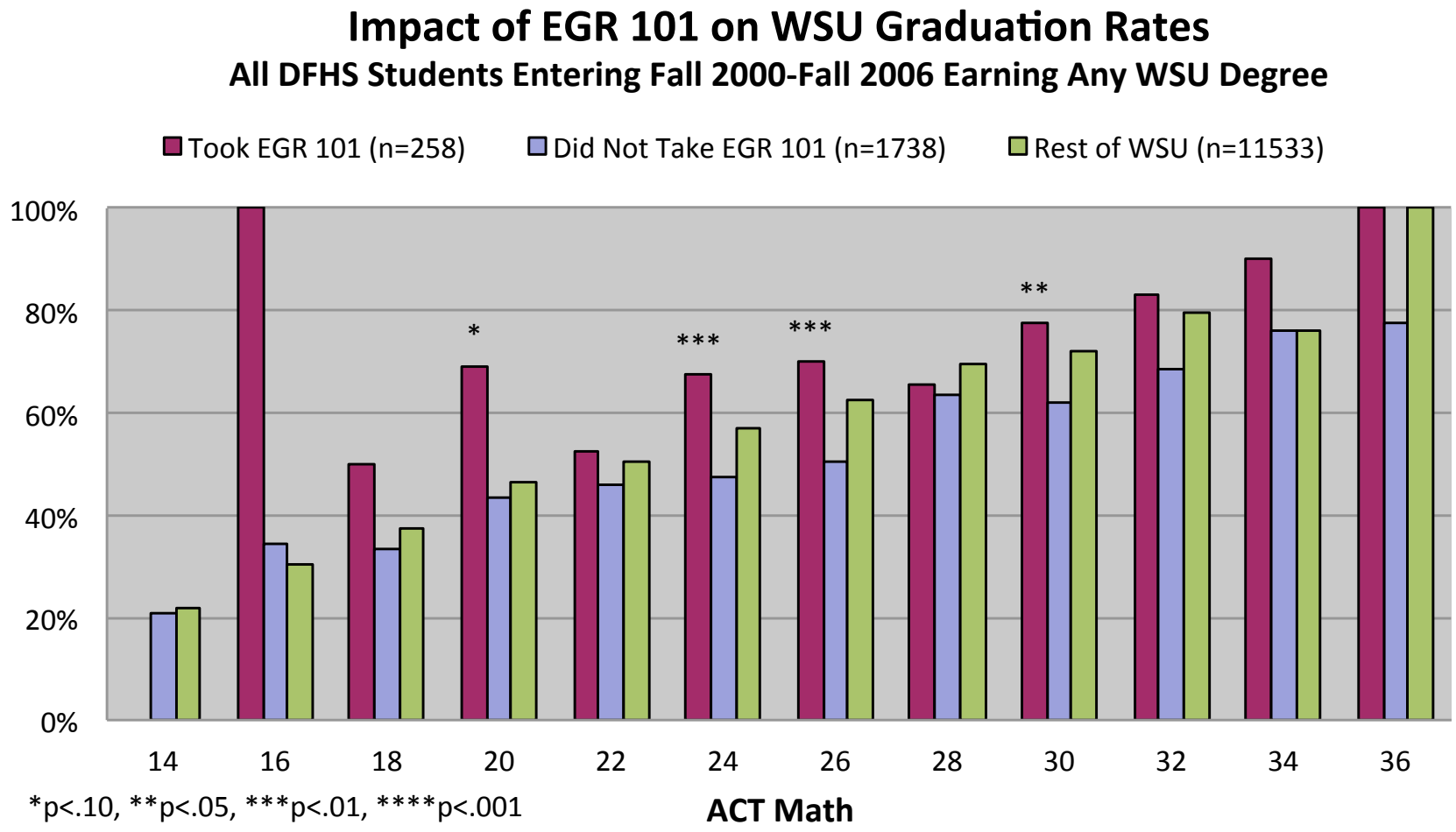
- On average, students who took EGR 101 were in fact somewhat more prepared, since many initially underprepared students dropped out before ever getting there.
- Still, a number of initially underprepared students did ultimately take the course.

And This Was the Result…



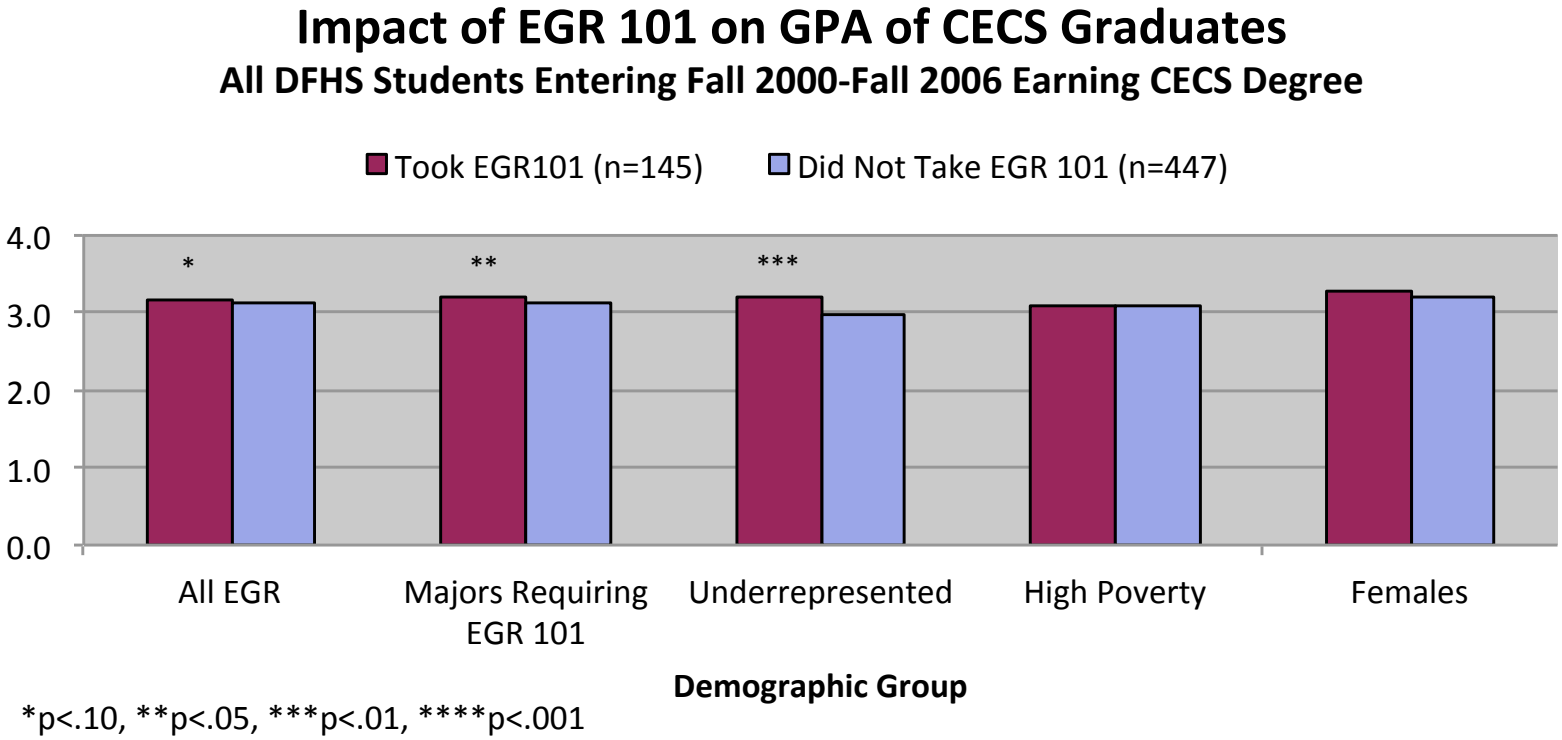
EGR 101 has successfully mitigated the impact of incoming math preparation over the entire range of incoming ACT math scores

And Even for the *Switchers*…



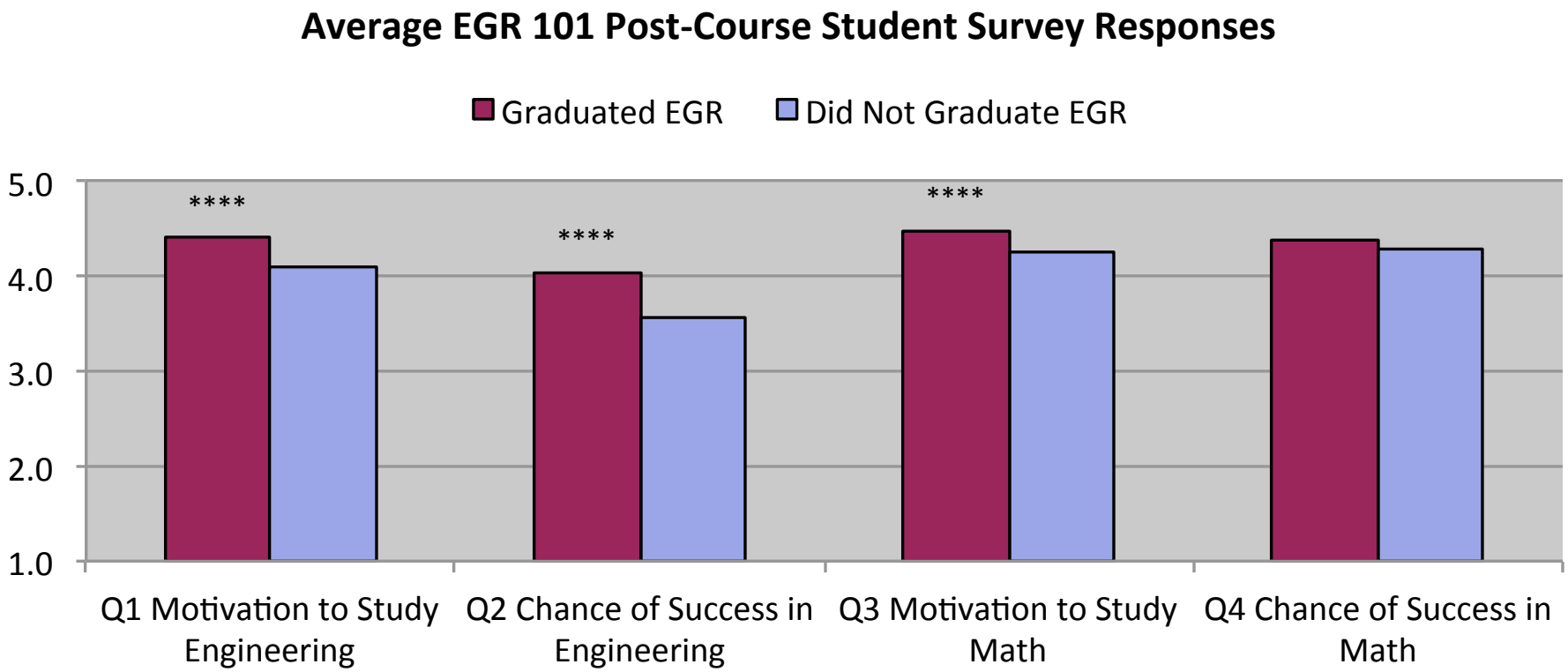
- Of students who took EGR 101, 70% earned Wright State degrees, compared to 51% of those who did not. Rest of WSU: 46%

What About the Caliber of Our Engineering Graduates?



- Despite graduating a higher proportion of initially underprepared students, EGR 101 has increased both the number and *caliber* of our engineering graduates.
- For underrepresented students, taking EGR 101 was the difference between graduating with a 2.9 GPA and graduating with a 3.0 – the interview cutoff for many prospective employers.

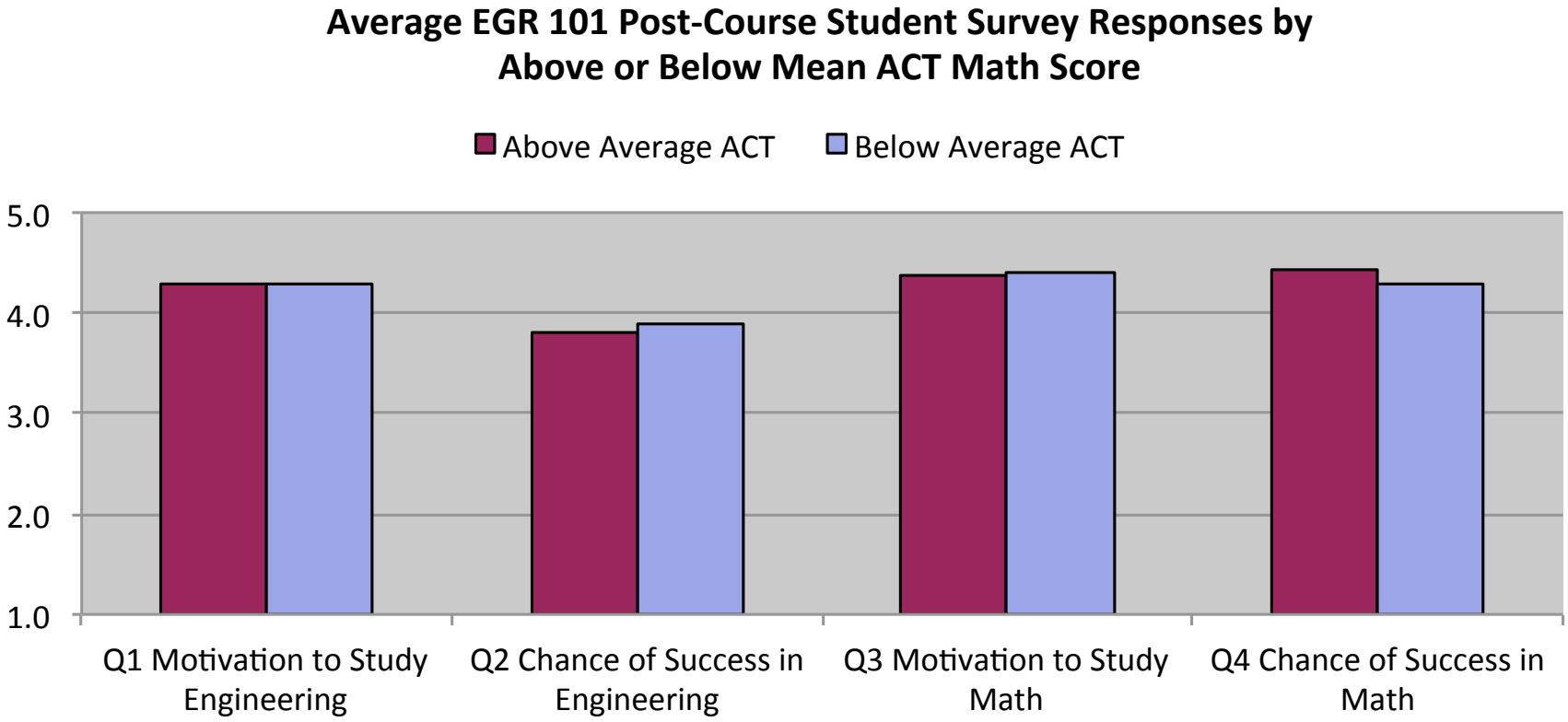
Longitudinal Study: Student Motivation and Self-Efficacy



*p<.10, **p<.05, ***p<.01, ****p<.001

- EGR 101 had a stronger impact on the motivation and self-efficacy of students who ultimately graduated in engineering, as compared to those who did not.

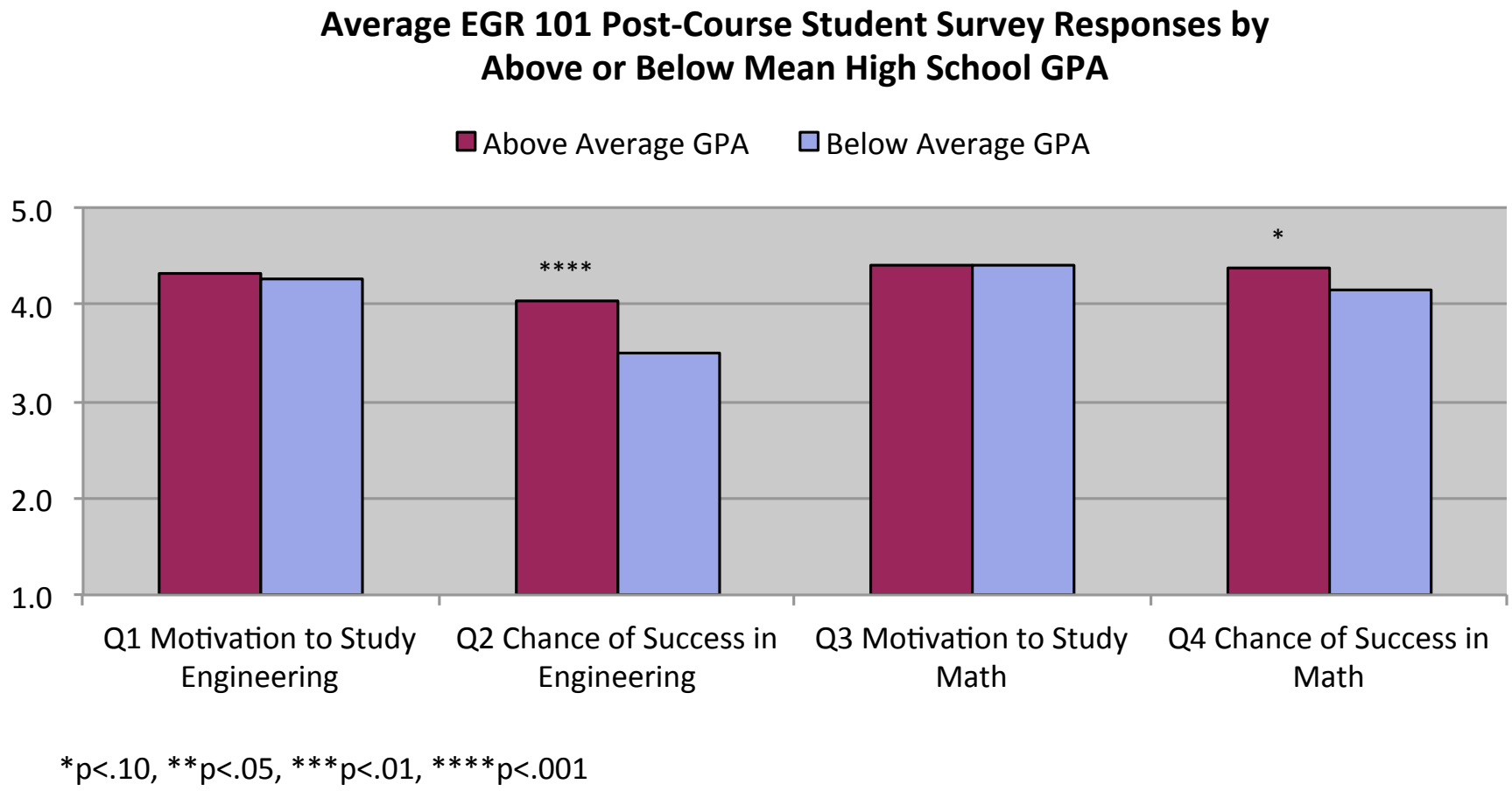
Impact on Motivation and Self-Efficacy Sorted by ACT Math



*p<.10, **p<.05, ***p<.01, ****p<.001

- EGR 101 had a positive impact on the motivation and self-efficacy of students having either above or below average ACT math scores, with no significant difference between groups.

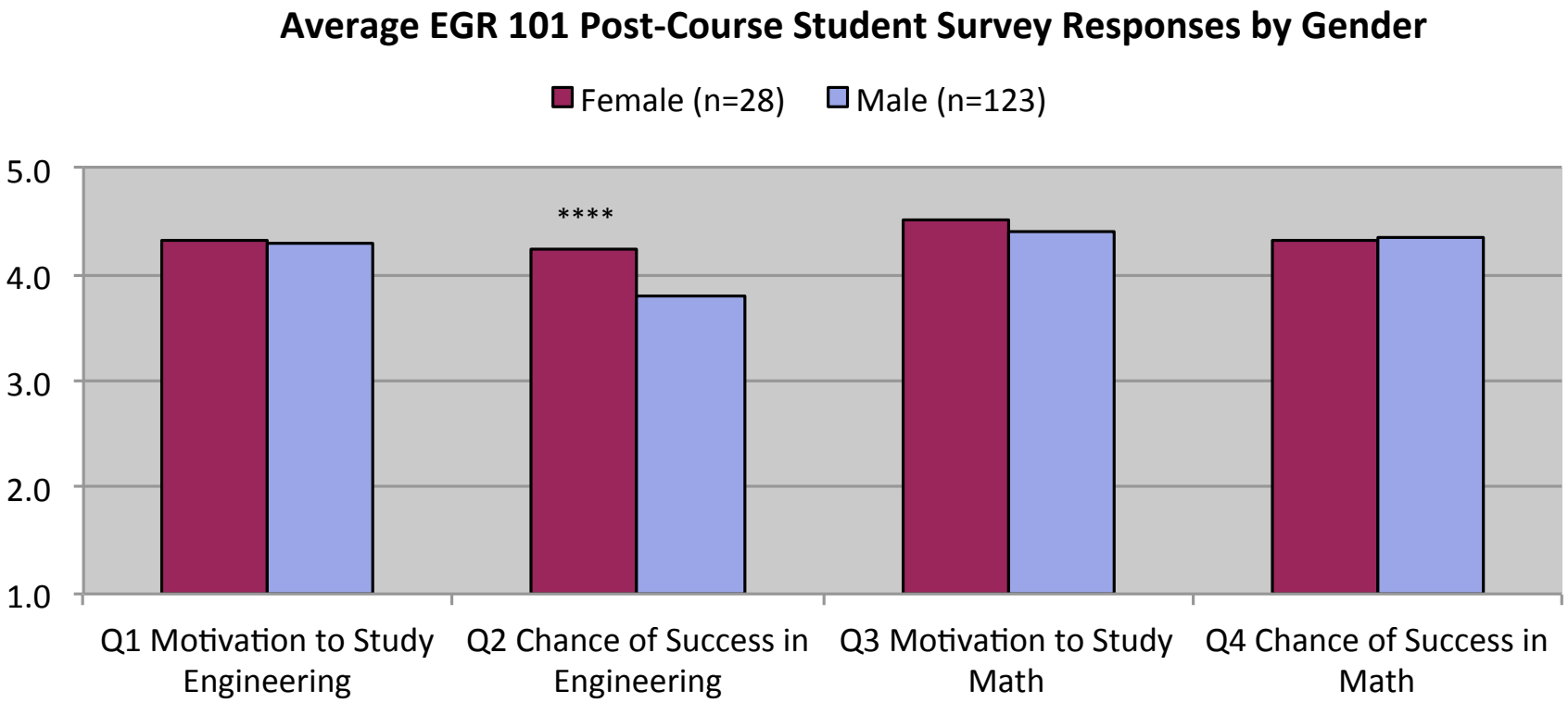
Impact on Motivation and Self-Efficacy Sorted by High School GPA



*p<.10, **p<.05, ***p<.01, ****p<.001

- EGR 101 had a stronger impact on the self-efficacy of students with above average high school GPA's (i.e., the hard workers), as compared to that of students with below average GPA's.

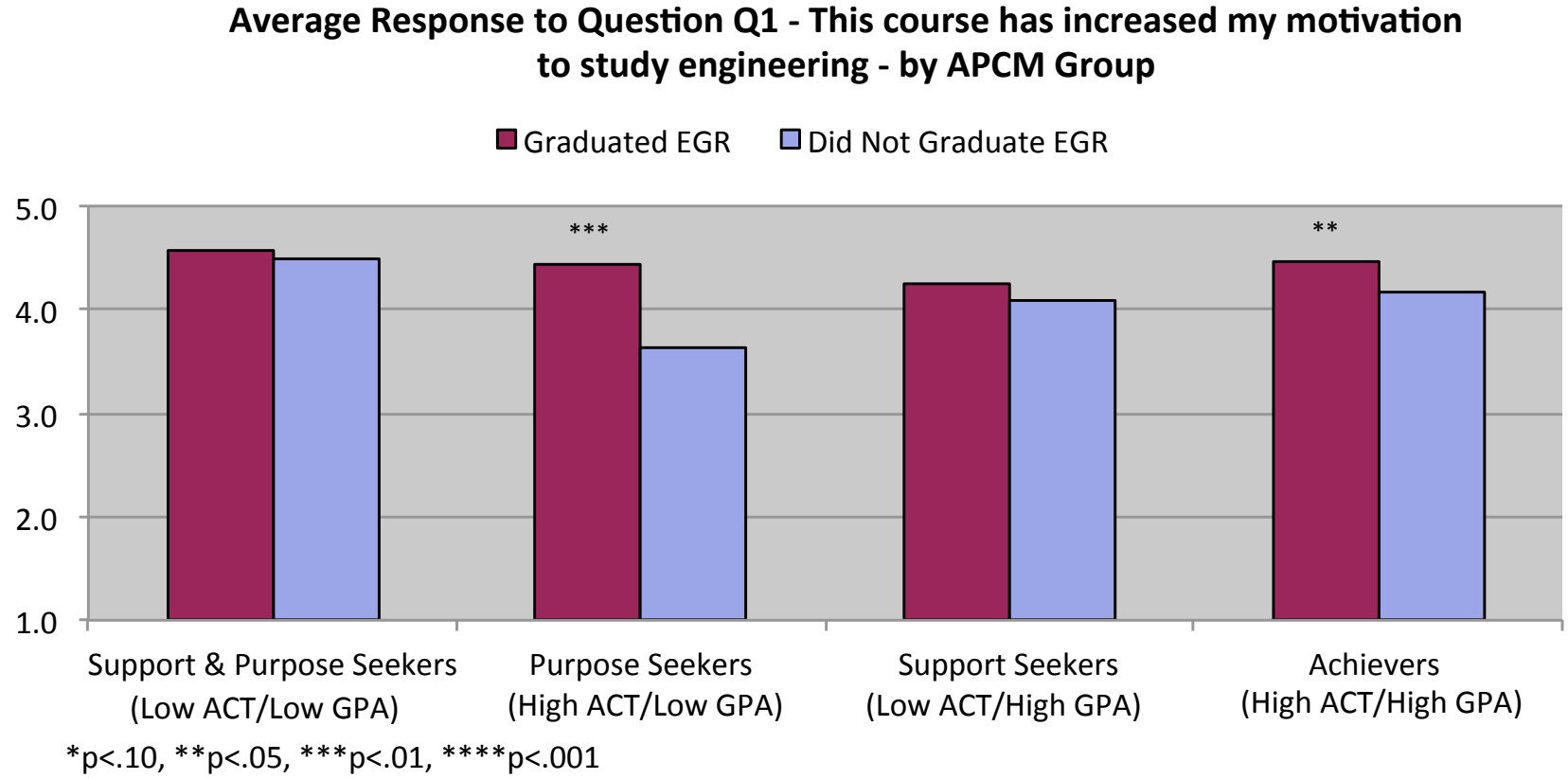
Impact on Motivation and Self-Efficacy Sorted by Gender



*p<.10, **p<.05, ***p<.01, ****p<.001

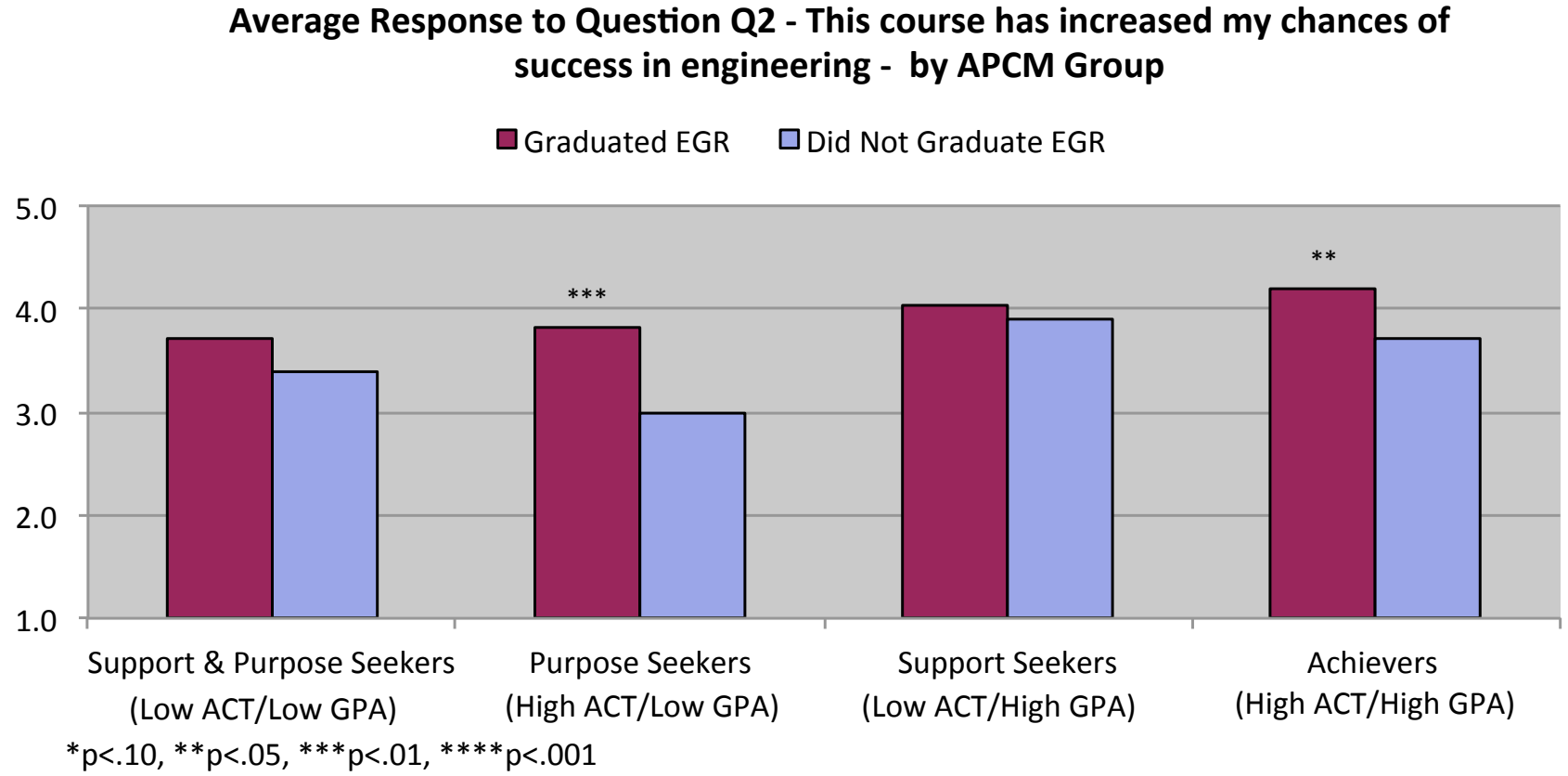
- EGR 101 had a stronger impact on the self-efficacy of females as compared to males
- About 90% of the female population had above average high school GPA's (i.e., they were hard workers). EGR 101 helped them *believe* they could do it.

Impact on Motivation Sorted by APCM Group



- In the context of the Academic Performance Commitment Matrix (APCM), EGR 101 had the greatest impact on the motivation of Support & Purpose Seekers, regardless of whether or not they ultimately graduated
- For both the Purpose Seekers and Achievers (high ACT students), there was a statistically significant difference between those that did and did not graduate

Impact on Self-Efficacy Sorted by APCM Group



- With the exception of Achievers who ultimately graduated, EGR 101 had the greatest impact on the self-efficacy of Support Seekers, regardless of whether or not they ultimately graduated
- For both the Purpose Seekers and Achievers (high ACT students), there was a statistically significant difference between those that did and did not graduate

Pre-College Implementations of EGR 101 Materials

- Dual-Enrollment of EGR 101: Bellbrook High School, the Dayton Regional STEM School, Carroll High School (Fall 2014). Other Dayton area schools under consideration.

- Dayton Regional Summer STEM Academy: Three week summer program for rising juniors and seniors

- 36 week high school engineering mathematics curriculum at Chantilly High School Academy (Fairfax County, VA)

- Offerings at DC area high schools (Friendship Collegiate Academy, Oxon Hill High School) with University of Maryland credit

- Multiple school districts under consideration across the country

NSF CCLI Phase 3 Program

"A National Model for Engineering Mathematics Education"

Grant Number DUE-0817332, 08/01/08-07/31/14

Total Funding: $2,400,000 – Including 2013 HBCU Supplement

18 Collaborating Institutions:

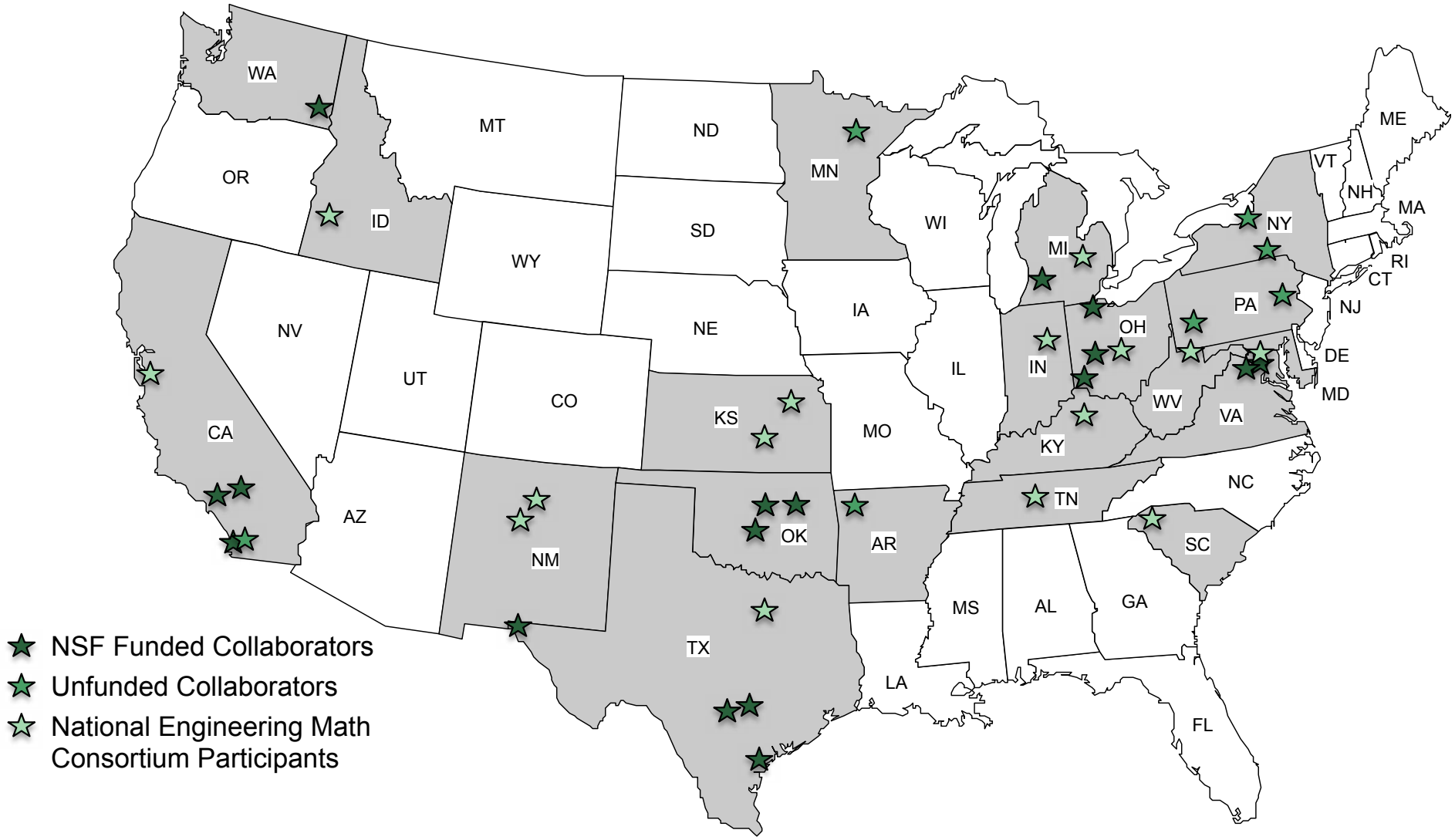
California Baptist University, California State University-Long Beach, Chantilly Academy (Fairfax County Public Schools, VA), **Howard University**, **Morgan State University**, Oklahoma Christian University, Oklahoma State University, San Antonio College, Texas A&M University - Kingsville, University of Cincinnati, **University of Maryland Eastern Shore**, University of San Diego, University of Texas at El Paso, University of Texas at San Antonio, University of Toledo, University of Tulsa, Washington State University, Western Michigan University

External Evaluator:

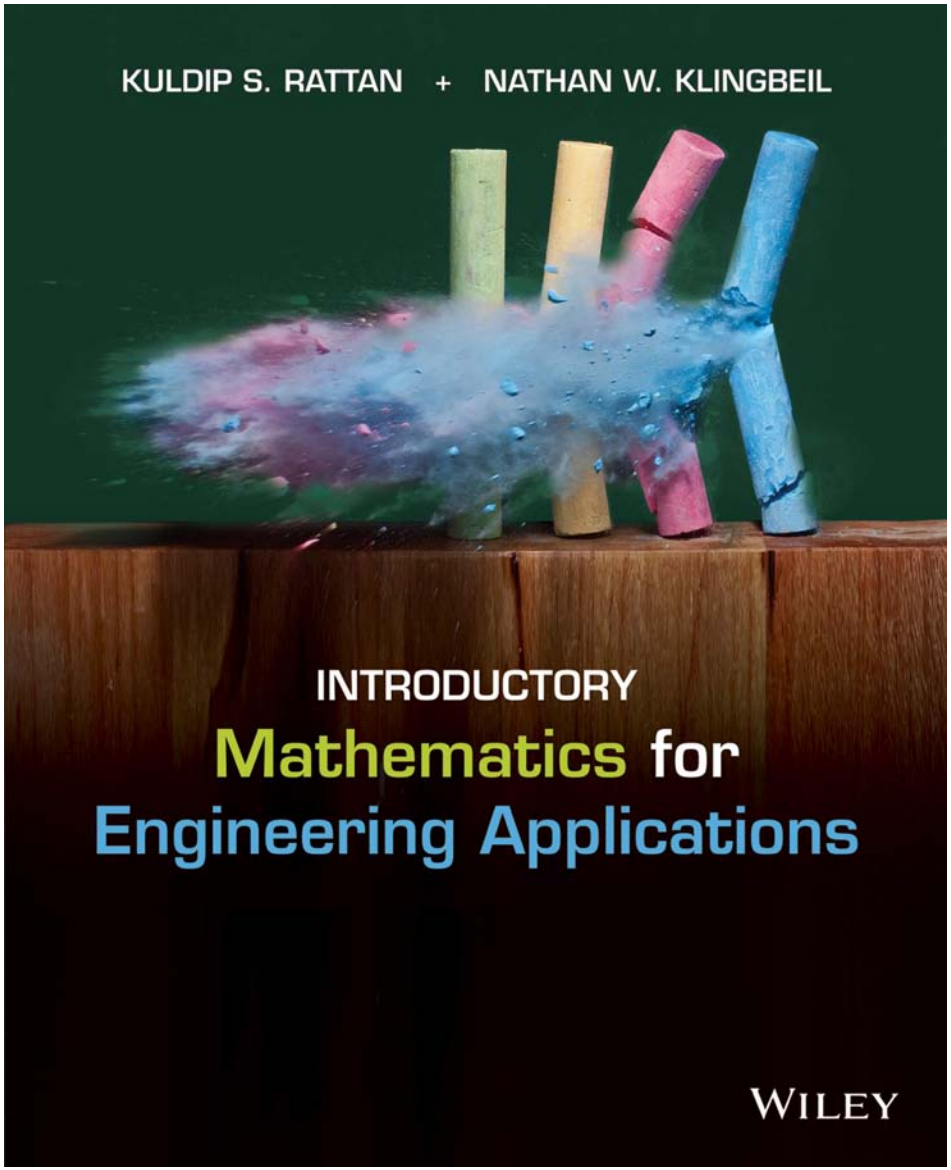
University of Maryland - College Park

Potential for National Impact

10,000 More Engineers… Times *Seven*



Questions
(And Shameless Plug)



http://www.wiley.com/college/rattan