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University of Toledo
Engineering Applications of Mathematics

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Undergraduate Engineering at UT

- ABET accredited Engineering Science programs
  - BioE, ChE, CivE, CSE, EE, ME
  - Target population for Applications of Engineering Mathematics supplement
- ABET accredited Engineering Technology programs
  - Construction, Computer, Electrical, Information Technology and Mechanical
- Engineering Science credentials: ACT composite 25.6, ACT Math 26.9, HS GPA 3.64
- First to second year retention is greater than 70% remaining in Engineering, greater than 80% remaining at UT
- Mandatory co-op program for all Engineering Science students
  - Three semesters of co-op are required
  - Requires students to stay on schedule within their curriculum
- University System of Ohio accountability measures for STEM enrollments, retention and timely graduation
  - UT emphasis on retention and timely graduation of Engineering Science students who arrive underprepared in math

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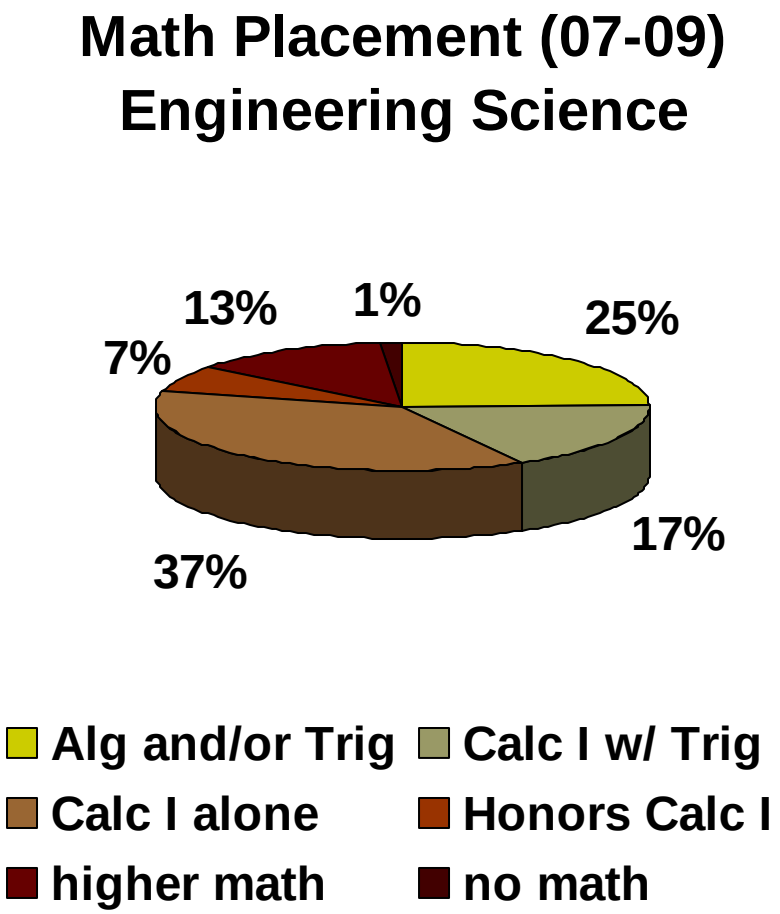
Mathematics for UT Engineering

- Various initial Mathematics offerings for UT Engineering students depending on level of preparation
  - MATH 1320 College Algebra (3 hrs)
  - MATH 1330 Trigonometry (3 hrs)
  - MATH 1340 College Algebra and Trigonometry (4 hrs)
  - MATH 1980 Trigonometry Review (1 hr)
  - MATH 1850 Calculus I (4 hrs)
  - MATH 1920 Honors Calculus I (4 hrs)
- Resulting pathways to Calculus I for new students
  - Start in MATH 1320 and/or MATH 1330 before MATH 1850
  - Start in MATH 1340 before MATH 1850
  - Direct entry into MATH 1850 supplemented by MATH 1980
  - Direct entry into MATH 1850 without supplemental instruction
  - Qualifying honors students can choose MATH 1920 instead of MATH 1850
  - Students with AP, IB or post-secondary credit can go directly into Calculus II

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Mathematics Placement

- Placement in Mathematics courses based on various factors
  - ACT or SAT Mathematics score
  - Elementary or College Algebra placement test
  - Trigonometry placement test
- Our goal is to have prepared students take Calculus I as soon as possible
  - Required for Physics and subsequent Engineering coursework
  - Many students go out on their first co-op after their 3rd semester of courses
  - 3 out of 4 first year students are on target or ahead



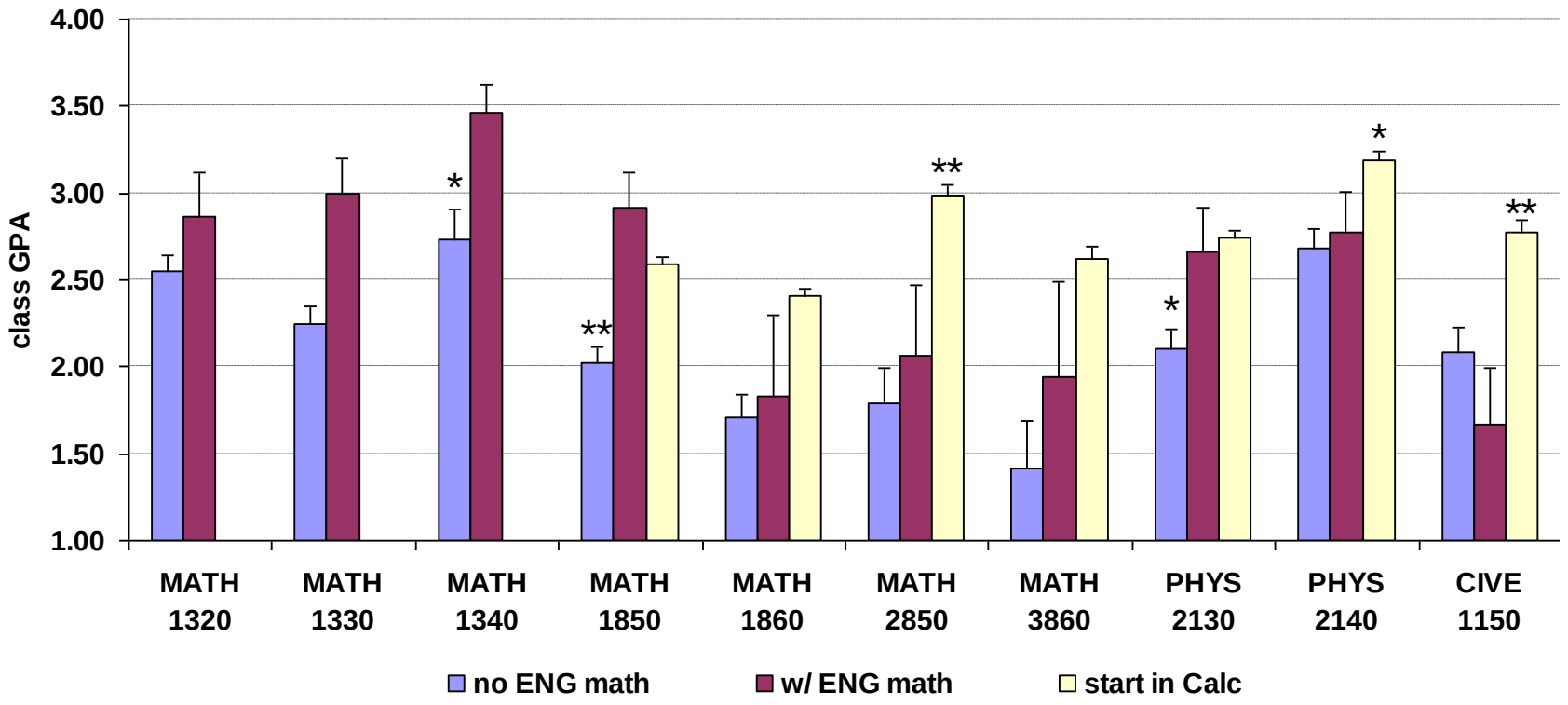
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UT Engineering Applications Course

- Supplement instruction for students that place into MATH 1320/30/40 Algebra and Trigonometry courses
  - Goal is to improve student performance when they take Calculus I
- Adapted Wright State *Mathematics for Engineering Applications* course materials to create optional course
  - Topics range from vectors to differential equations
  - Present applications for each topic then introduce theory
  - Parallel hands-on laboratory reinforces lecture topics
- Provide tangible benefits to encourage students to enroll
  - Reimbursed students for extra tuition incurred for taking course
  - Physics department allows students that complete this course to enroll in Physics I and Calculus I simultaneously

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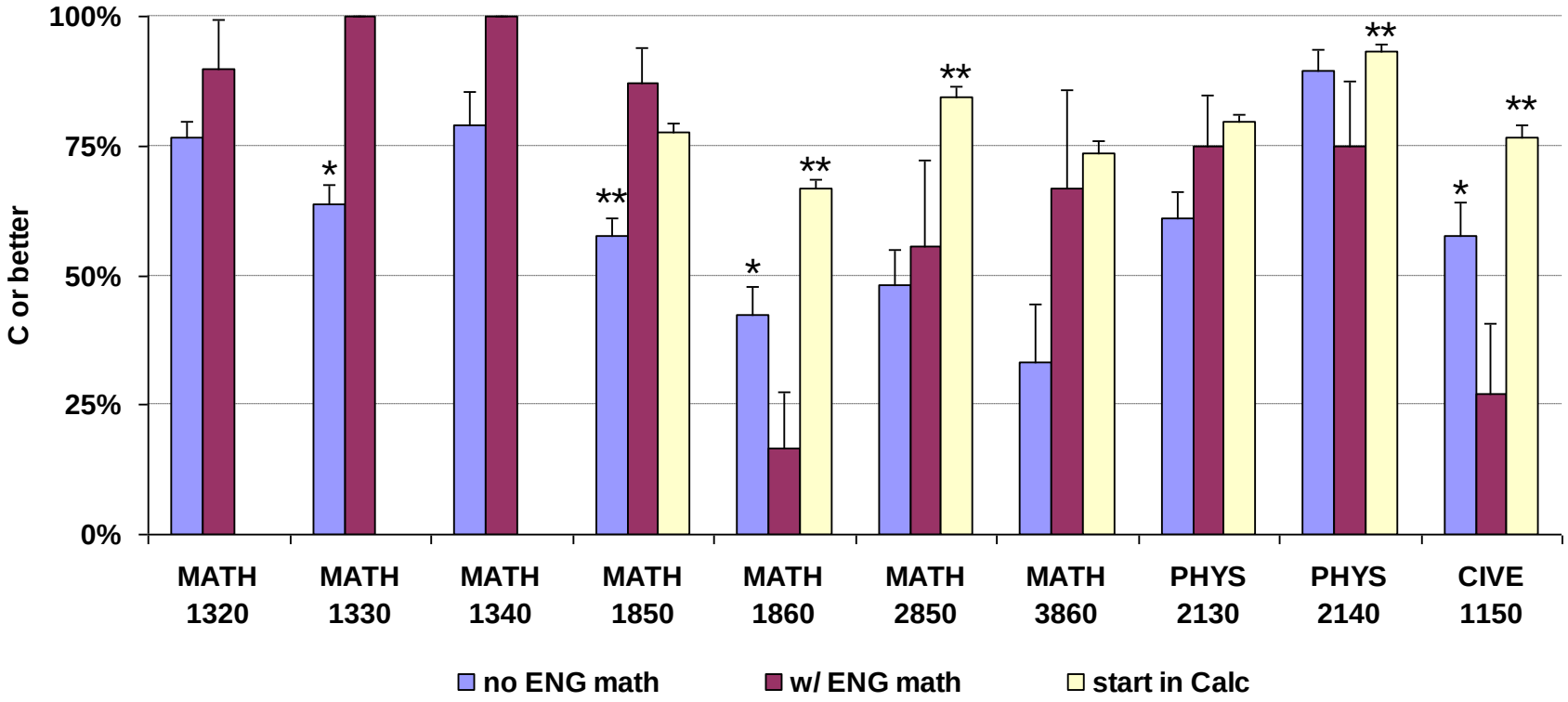
GPA in core courses



Students with ENG math vs. students without ENG math and vs. students starting in Calculus (* p < 0.05, ** p < 0.01)

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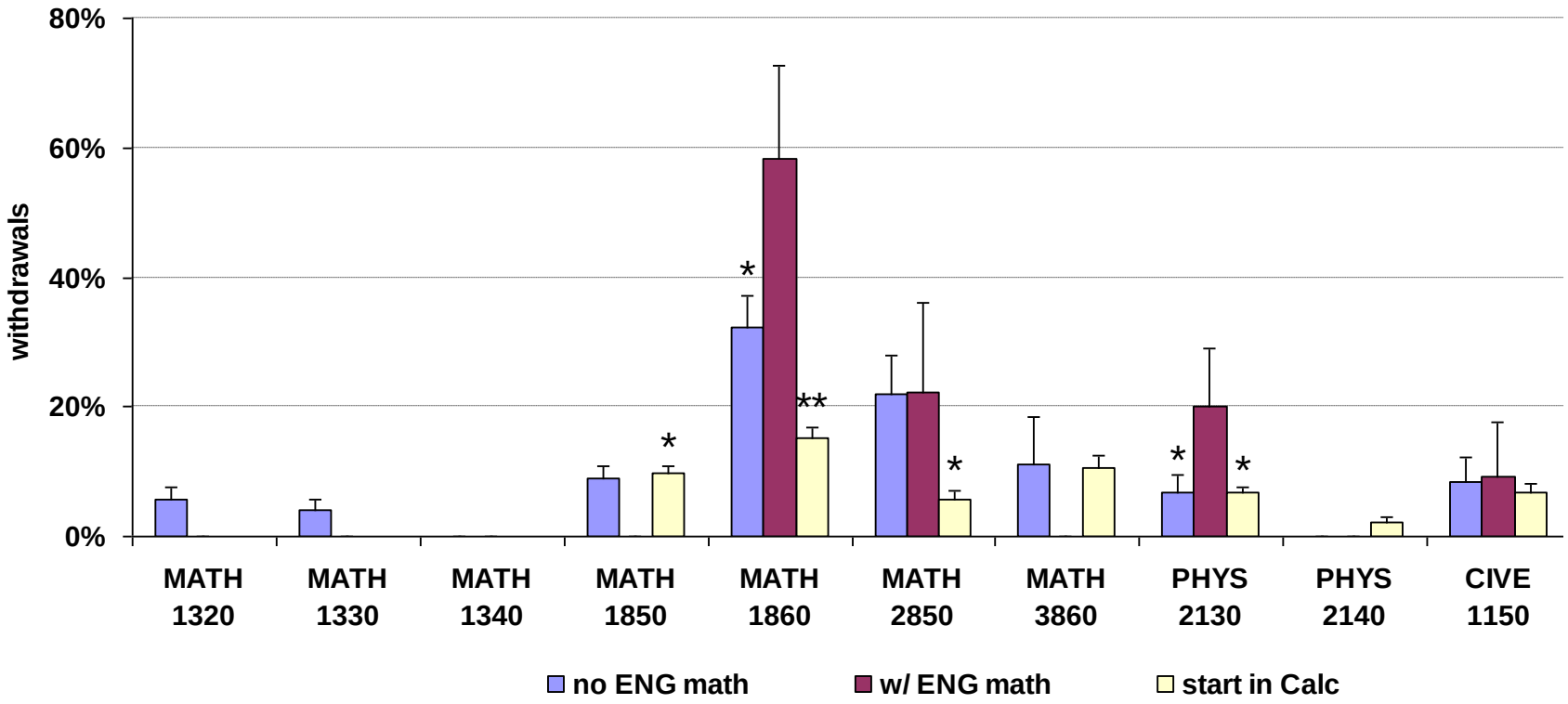
C or better in core courses



Students with ENG math vs. students without ENG math and vs. students starting in Calculus (* p < 0.05, ** p < 0.01)

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Withdrawal rate from core courses



Students with ENG math vs. students without ENG math and vs. students starting in Calculus (* p < 0.05, ** p < 0.01)

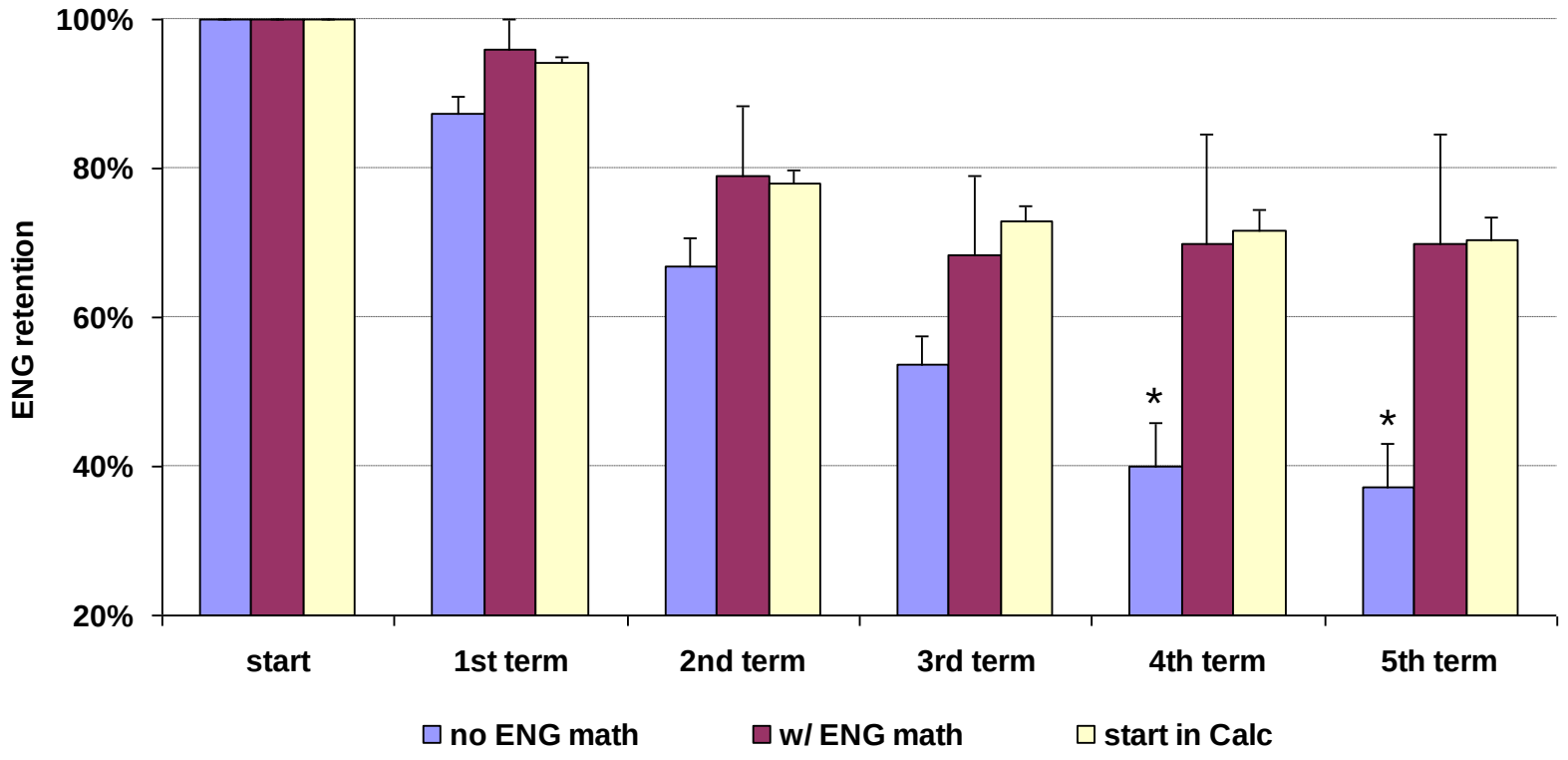
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Summary of performance results

- Improved math and Physics performance in semester during and after ENG math course
  - ENG math students perform better than non-ENG math control group in concurrent pre-calculus courses
  - Significant improvement in first Calculus and Physics courses during the following semester
- Gains from ENG math course are not sustained during subsequent Calculus and Physics courses
- Poor performance of ENG math students in first core ENG course (Statics)
  - Unexpected result with focus of ENG math course on ENG applications
- Sustained gains in persistance for ENG math students despite lack of sustained improvement in subsequent courses
  - Additional retention analyses performed

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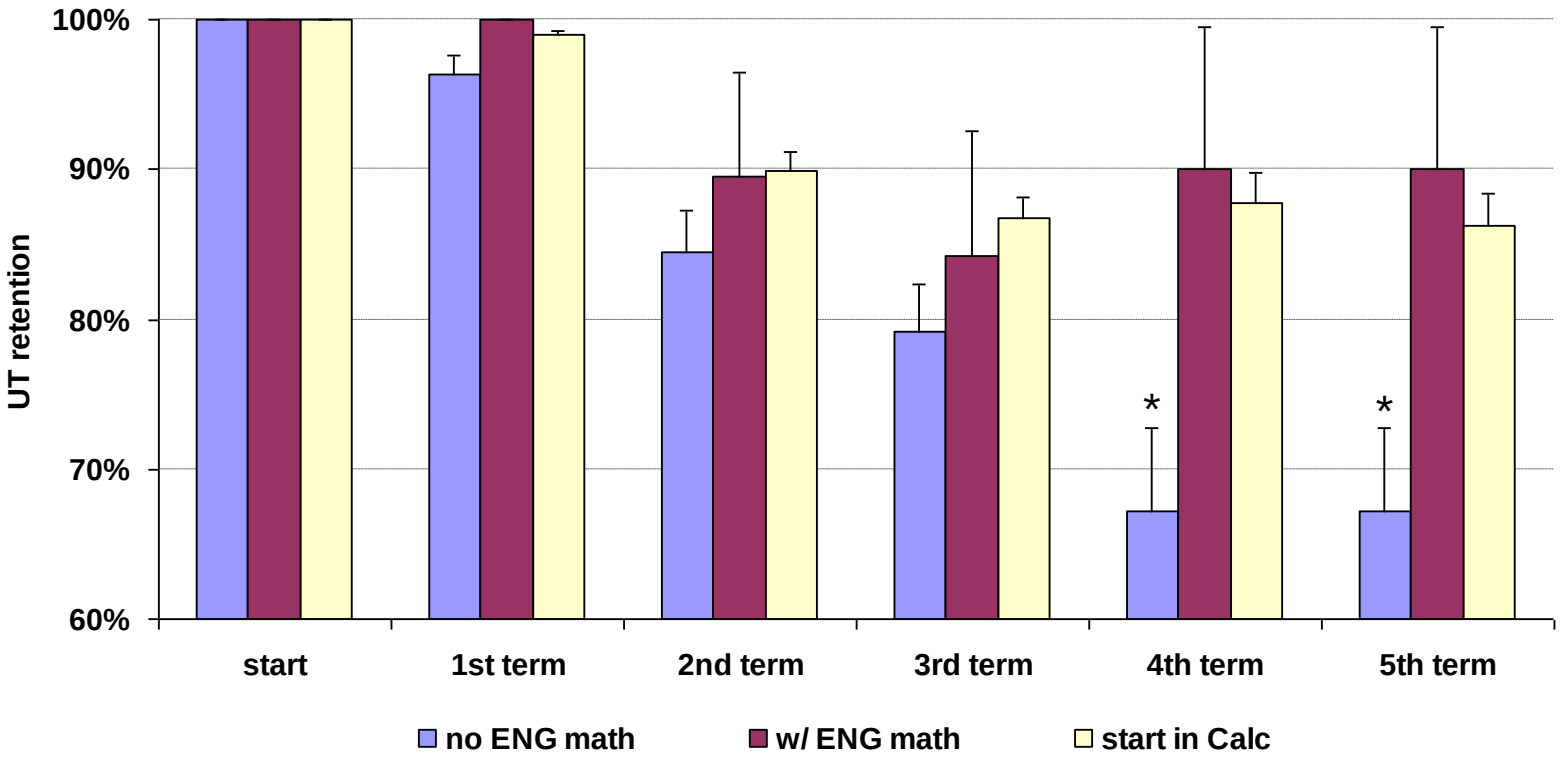
Retention rates in ENG



Students with ENG math vs. students without ENG math and vs. students starting in Calculus (* p < 0.05, ** p < 0.01)

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Retention rates at UT



Students with ENG math vs. students without ENG math and vs. students starting in Calculus (* p < 0.05, ** p < 0.01)

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Conclusions and future directions

- ENG math course provides tangible benefits to ‘under-prepared’ students in their first Calculus and Physics courses
- Lack of sustained benefit in later Calculus and Physics courses suggests need for continued support
  - Booster course, tutoring or peer mentoring programs during subsequent semesters
- Improved retention is a clear, sustained benefit
- Investigating partnership with Math Department to extend benefits of this course to more students
- Possibility to extend a version of this course as gateway to core ENG courses taken during 2nd year
  - Mass & energy (CHEE), circuits (CSE/EE), statics (CIVE/ME)
  - Some instructors observe that students lack sufficient algebra skills
  - Could develop placement testing for entry to 2nd year ENG courses