The Gatekeepers of STEM

Addressing Inequity in Applied Math Foundation Courses

JET Fall 2025 Capstone Action Plan

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Students who switch (out of STEM) following a “weed-out” course are *not* a random group…these students differ from persisters by a set of intersecting factors that include:
how they respond to poorer-than-accustomed grades, their gender, race/ethnicity, socio-economic status, and major.

-Seymour and Hunter, *Talking About Leaving Revisited, 2019,* pp 217 (emphasis mine)

Analyzing Applied Math Foundation Courses

Weed Out Course Characteristics

Commonalities: Harsh assessment, misaligned content, outdated teaching modes (1)

Table 7.1 Characteristics of weed-out classes as identified by all interviewees, and by switchers and persisters, as a percentage of their group

	All students $N = 346$		Switchers $N = 96$		Persisters $N = 250$	
Characteristics	*N*	%	*N*	%	*N*	%
Assessments misaligned w/content and understanding (including curved grading)	116	29	30	31	86	34
Heavy volume and pace	82	20	15	16	67	27
Level too high/abstract for intro class	60	15	18	19	42	17
Rote learning/dull content in lecture mode	54	13	13	14	41	16
Teacher indifferent whether learn: Learning alone w/out help	44	11	15	16	29	12
Incoherent organization, missed steps or explanations	30	7	8	8	22	9
Competitive class culture	19	5	9	9	10	4
All observations	405	100	100	113[a]	297	118[a]

[a]Group percentages total more than 100% because students cited multiple characteristics

Seymour and Hunter, 2019

The Four Core Courses

Applied Math (APPM) foundation courses:

- Calculus 1 for Engineers
- Calculus 2 for Engineers
- Calculus 3 for Engineers
- Differential Equations with Linear Algebra

These four courses are suggested in four-year degree plans by many CU Boulder STEM departments, including Engineering, ATOC, Computer Science, etc.

Are These "Weed Out" Classes?

- **Assessment weighting:** 4 high-stakes timed exams, worth 65% (Differential Equations) to 80% (Calculus 1) of total grade
- **Large lecture sizes:** Average Calc 1 lecture capacity of 122 (Fall 2025)
- **Median exam grades:** Median exam grades within C-letter range (Summer 2025)
- **Fast-paced course content:** Four-course sequence covers material taught over 5 semesters in, e.g., CU Boulder Math department

How Do We Fix It?!

- Research suggests a few, primary issues contribute most to inequitable outcomes:
  1. High stakes timed assessments disproportionately affect students who identify as women (Galasso & Profeta, 2024)
  2. Outdated, passive teaching paradigms (lecturer/student) affect all students negatively, but especially underrepresented students (Seymour and Hunter, 2019)
- Small changes can make big waves!
  1. Outcome-based assessment methods for equitable assessment (Torrey, 2021)
  2. Active learning changes to lecture environment substantially improves student performance, especially in underrepresented groups (Kramer et. al., 2023)

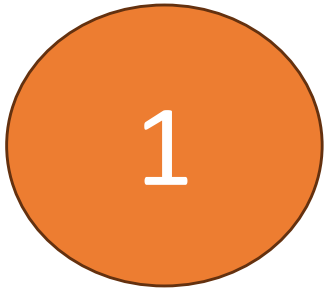
Course Action Proposal

Overview:

1. Identify practical areas for improvement based on existing equity research and APPM-specific insights.
2. Propose implementation of alternative course delivery and assessment methods based on research stage.
3. Set measurable targets on student retention in foundation course sequence and subsequent STEM courses.

Stakeholders:

- APPM Undergraduate Coordinator
- Individual course coordinators
- Faculty, TAs
- Students



Step 1: Inequity Research

- **Plan:**
  - Use central course portals to gain student permission
  - Analyze anonymized assignment/course grades vs demographic info
  - Investigate whether national trends (1, 2, 3) in performance of women & minorities apply to APPM
  - Identify problem areas, e.g. inequity in exam grades
  - Separately: assess TA and faculty available resources (in progress)
- **Timeline:** Fall 2025 – Spring 2027
- **Risks:**
  - Ethical data collection: requires both faculty and student uptake

Step 2: Finalize Proposal

- **Plan:**
  - Use data from step 1 research to propose final course updates
  - Potential updates:
    - Additional planned interactivity in lecture
    - Outcome based assessment, including altered assessment schedule (smaller assessments, delivered frequently)
- **Timeline:** Fall 2027
- **Risks:**
  - TA resource changes planned by division (possibility of fewer graders)

Step 3: Implement Updates

- **Plan:**
  - Work with faculty and TAs to implement feasible updates
  - Set measurable targets based on step 1 research for continuing observation
- **Timeline:** Spring 2028 & Beyond
- **Risks:**
  - Coordinating updates across several large sections
  - Continued ethical data collection

Citations

- Galasso, Vincenzo and Profeta, Paola. *Gender Differences in Math Tests: the Role of Time Pressure.* **The Economic Journal,** Volume 134, Issue 664, November 2024, Pages 3461–3475. https://doi.org/10.1093/ej/ueae052
- Laird Kramer et al. *Establishing a new standard of care for calculus using trials with randomized student allocation.* **Science** 381, August 2023, Pages 995-998. https://doi.org/10.1126/science.ade9803
- Seymour, Elaine and Hunter, Anne-Barrie, ed. **Talking About Leaving Revisited.** Springer Nature Switzerland, 2019. https://doi.org/10.1007/978-3-030-25304-2
- Torrey, Rebecca. *Outcomes Based Assessment – Structural Changes in Calculus.* **On Teaching and Learning in Mathematics,** American Mathematical Society Blogs, July 31, 2021. https://blogs.ams.org/matheducation/2021/07/31/outcomes-based-assessment-structural-change-in-calculus/