

REBUILD

Researching Evidence Based Undergraduate Instructional and Learning Developments

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Introduction

In the future, faculty and students at Michigan will share a collective expectation that STEM education will be evidence-based, continually refined, and delivered by multi-generational teams including post-docs, graduate students, and undergraduates who all contribute to the excellence of the effort. Young apprentice scientists in these groups will join a community of practice in which evidence-based instruction and continuous assessment is the professional norm to be emulated. Achieving this goal will require a major culture change: a coordinated campaign of reform-from-within in the four core STEM disciplines of mathematics, physics, chemistry, and biology at the University of Michigan. At its center will be REBUILD—Researching Evidence Based Undergraduate Instructional and Learning Developments—a committee of twelve senior faculty with a strong staff, dedicated to changing the culture of STEM instruction.

Project Goals

REBUILD has received \$2 million in funding from the National Science Foundation, along with additional contributions from the U-M Office of Research and the Colleges of Engineering and Literature, Sciences, and the Arts. With these funds, the REBUILD committee will study the literature of evidence-based education, work with innovation leaders to select reform approaches, and coordinate a multi-year effort to embed evidence-based teaching across 21 massive introductory STEM courses: Physics 135, 136, 140, 141, 235, 236, 240, and 241; Chemistry 125, 126, 130, 210, 211, 215, and 216; Biology 171, 172, and 173; and Math 214, 215, and 216.

REBUILD Committee

1. Dr. Kenneth Cadigan (Molecular, Cellular, and Developmental Biology)
2. Dr. Brian Coppola (Chemistry)
3. Dr. Stephen DeBacker (Mathematics)
4. Dr. Gina Hedberg (Physics; Project Coordinator)
5. Dr. Benjamin Koester (Physics; Analytics Lead)
6. Dr. Lisa Lattuca (School of Education)
7. Dr. Timothy McKay (Physics; Principal Investigator)
8. Dr. Anne McNeil (Chemistry)
9. Dr. Laura Olsen (Biology)
10. Dr. Aaron Pierce (Physics)
11. Dr. David Speyer (Mathematics)
12. Dr. Patricia Wittkopp (Ecology and Evolutionary Biology)
13. Dr. John Wolfe (Chemistry)
14. Dr. Mary Wright (Center for Research on Learning and Teaching)

Why Restructure Introductory STEM Courses?

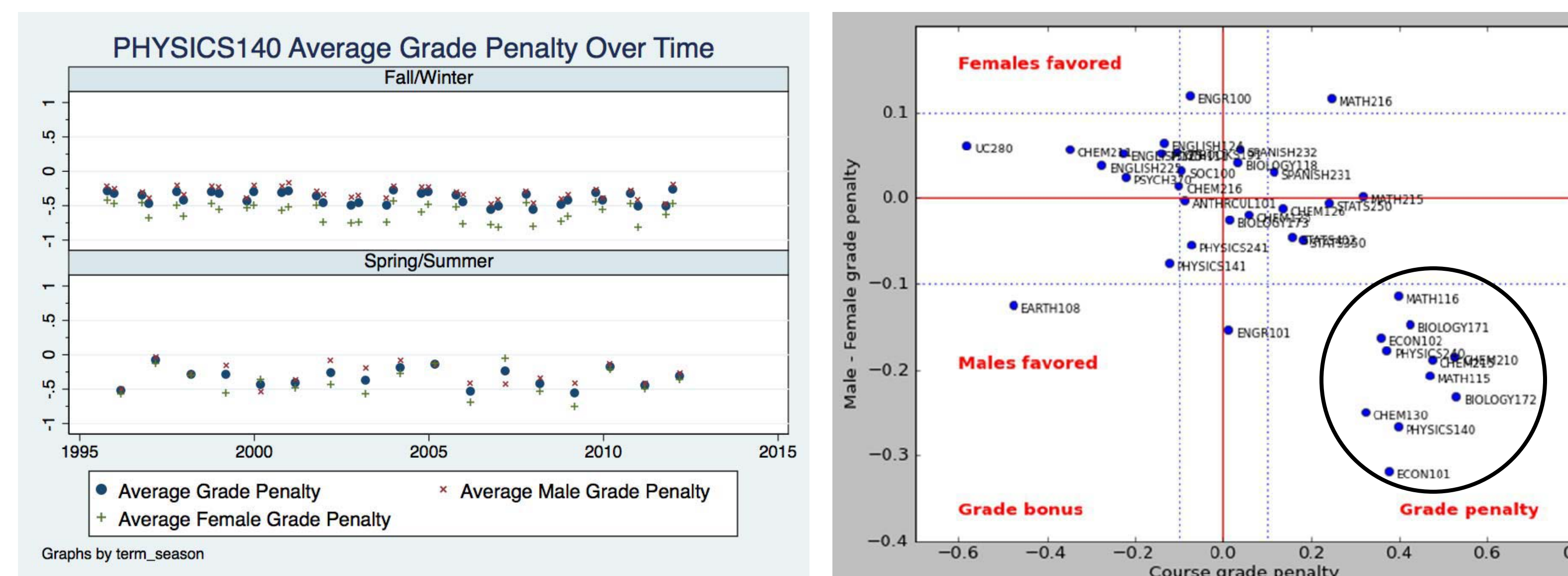


Figure 1. Grade Penalty in STEM courses, defined as the mean of the difference between course grade and student GPA. *Left panel:* Grade penalty by term in Physics 140. *Right panel:* Grade penalty for intro STEM courses, emphasizing the disparity between genders.

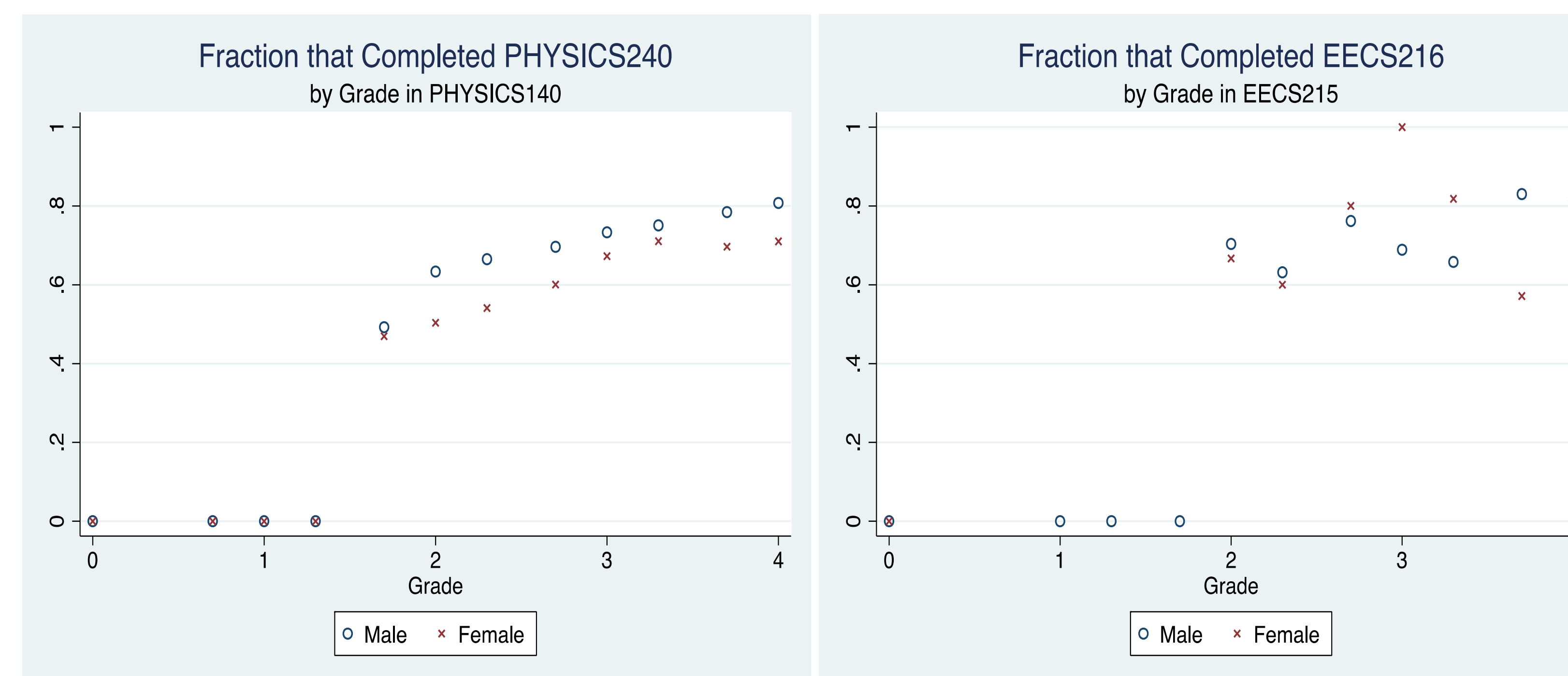


Figure 2. Examining gender disparities in persistence, defined as the probability that a student continues to the next course in a sequence, given her grade in the previous course.

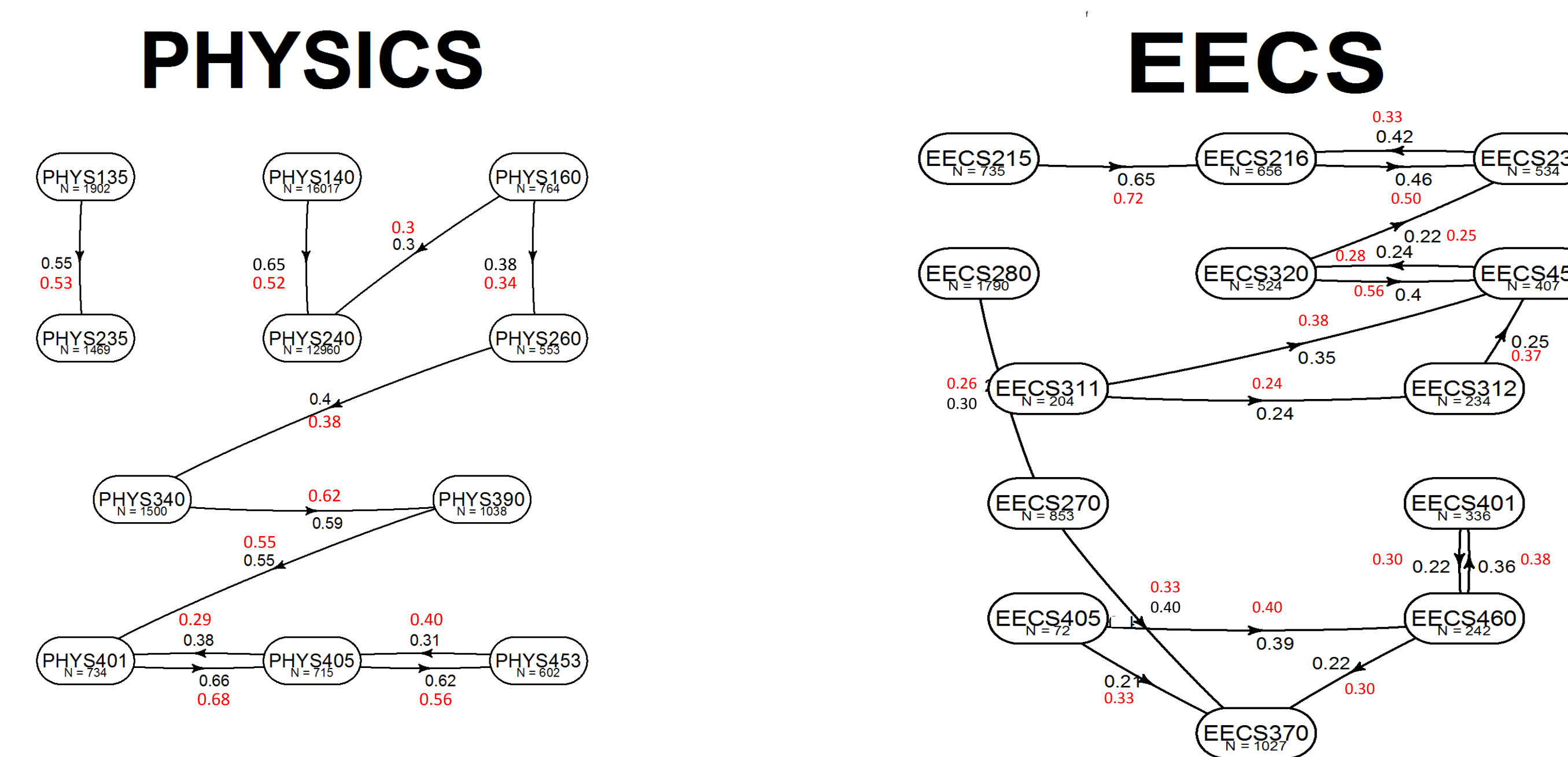


Figure 3. The flow of students through lower and upper level undergraduate courses. Persistence for males (black) and females (red) between Physics courses (left) and EECS courses (right).

Project Timeline

- *January 2014-summer 2014:* REBUILD study and presentation planning.
- *Fall 2014:* Learning analytics presentations to departmental leadership. Present at Provost's Seminar on Teaching. Oversee development of departmental reform teams.
- *Winter 2015:* Presentations to reform teams regarding learning analytics and innovative teaching techniques. Hold first round of presentations in departmental colloquia.
- *Summer 2015:* Implement reform strategies in planning of Fall 2015 courses. Continue research.
- *Fall 2015:* Launch of reformed courses. Hold second round of presentations in departmental colloquia.
- *Winter 2016:* Revised presentations to reform teams. Hold third round of presentations in departmental colloquia.
- *Summer 2016:* Implement reform strategies in planning of Fall 2016 courses.
- *Fall 2016:* Launch of reformed courses. Hold fourth round of presentations in departmental colloquia.
- *Winter 2017:* Final presentation at the Provost's Seminar on Teaching.

Discussion

Despite an ever-increasing need for competent scientists, engineers, and mathematicians, less than half of the students that declare a STEM major as an undergraduate continue on to complete the degree. Further, when one analyzes the grade penalties for these courses, glaring gender and race disparities become apparent. To address these issues, we must rethink our approach to undergraduate STEM education. Although a tremendous amount of research has been done regarding active and engaged learning, many instructors still hesitate to change how they teach their courses. This may be due to a lack of understanding regarding technological advances, resistance to changing courses that have been taught the same way for years, or even fear of failure. REBUILD will provide resources and knowledge to STEM faculty so that they feel supported and confident in their steps toward course reform.

To spread its message of change to all STEM faculty and students, REBUILD will develop research-to-reform presentations describing evidence-based instructional methods and reporting detailed results of their application at Michigan, which will be delivered in regular department colloquia across the STEM disciplines. By the end of this three-year period, REBUILD will have become an interdisciplinary nucleus for culture change in STEM instruction. It will have put 21 courses enrolling more than 8,000 students per term through an intense two-year process of evidence-based reform, and used more than 20 department colloquia to set a new professional standard for STEM instruction among students and faculty in five large, core STEM departments at Michigan.