Research Brief
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Persistence, Engagement, and Migration in Engineering Programs

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Those responsible for designing, maintaining, and delivering engineering education are asking questions to understand the outcomes of undergraduate engineering programs. These questions have been motivated by concerns about the declining interest in studying engineering, the continued lack of gender and ethnic diversity in the engineering population in education and practice, and the effectiveness of programs in preparing engineering graduates to take on today's engineering challenges.

Implications of Findings

Our growing understanding of how particular in-class and out-of-class strategies work to increase persistence in engineering may be useful in making engineering more attractive and transparent to non-engineering majors.

This study compared persistence and engagement of students in undergraduate engineering and in other college majors. We found that, in general, engineering students are more persistent than, and as engaged as, other college students. In comparing outcome and engagement factors ranging from grades and gains in general education to course-related interactions with faculty and time-on-task, students who matriculate in engineering do not stand out relative to students in other majors. Our data provide compelling evidence that lack of retention is not the major cause of the dearth of engineers being prepared in this country.

In this study, we were able to confirm the similarities between those who matriculate in engineering and students in other fields. Engineering students are as engaged and satisfied with their overall college experience and growth as are their peers in other majors. The research team expected to find lower rates of persistence, higher rates of attrition, and lower rates of satisfaction among engineers compared to other majors. These expectations were simply not borne out by the data. Engineering has the highest rate of persistence of any group of majors studied.

However, it would be a misinterpretation of our findings to conclude that everything is fine in engineering education. The findings do point to opportunities for improvement. That 90 percent of those studying engineering in their eighth semester in college were on the engineering pathway when they matriculated suggests that engineering has a problem attracting students once they begin their college careers. This may be because those who are undecided what to major in

when they matriculate are not attracted to engineering or because students believe that engineering requires a commitment prior to matriculating to college, beginning with high school preparation, college selection, etc.

These findings do not suggest that any less time, money, and effort should be put into student support programs. The focus that the engineering education community has given to retaining engineering students is likely responsible, at least in part, for the present level of persistence in engineering. Furthermore, the strategies that have typically favored improvements in persistence have also shown the greatest improvements for women and students of color.

Our growing understanding of how particular in-class and out-of-class strategies work to increase persistence in engineering may be useful in making engineering more attractive and transparent to non-engineering majors. Lessons learned from creating hands-on freshmen experiences, introductory design courses, and service learning are relevant to creating transparency and attractiveness. These lessons include:

1. Shifting to a "Passion Paradigm" in Designing Programs—distilling theory and practice to their essence and then trusting student passion to customize engineering learning.
2. Re-considering the Curriculum to Minimize What is Considered Essential and Required—Carnegie-Mellon offers a variety of engineering courses for students their first year that provide substantive exposure to the nature of engineering work within the various fields of engineering.
3. Viewing Engineering Education as Part of a Larger System—institutional policies can also drastically affect whom we graduate.

If we want to attract more students and a broader range of students, we have to do things differently. Both ordinary and extraordinary measures are needed.

Methods and Background

The central research question in this paper is:
How do the persistence, engagement, and migration to other majors of students who matriculate in engineering compare to those of students of other academic majors?

This paper examines engagement factors and educational outcomes of students in engineering majors as well as students in other fields of study, including arts and humanities, business, social sciences, computer science, and other science, technology, and mathematics (STM) fields.

This study builds on the work of Seymour and Hewitt (1997; see full paper for citation) in four main ways. First, we use the Multiple-Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) to compare persistence in engineering to persistence in other fields. MIDFIELD includes institutional data for nearly 70,000 engineering students from among over 300,000 first-time students from nine institutions who were studied in 13 cohorts over a 17-year period. Second, we use data from both MIDFIELD and the National Survey on Student Engagement (NSSE) to investigate the similarity of those who persist in engineering compared to those who do not and to extend the work of prior studies. The NSSE data include self-reported demographic and engagement items and scales for over 73,000 freshmen and

seniors from institutions representing all Carnegie Basic classifications. Third, we use an additional smaller data set from the Academic Pathways Study (APS) to provide some insight into why persisters and switchers interpret and act on similar experiences in different ways. APS begins to develop our understanding of the relationship between persistence and engagement. Finally, we use NSSE survey data to compare the experiences of engineering students to those of students in other majors.

What We Found

The major results of this study are:

1. Engineering has the highest rate of persistence and the lowest rate of inward migration.
2. Except for the low proportion of women, engineering students are demographically similar to other college students.
3. Engineering students might think their grades are lower, but they are not.
4. Engineering students are similar to other students in terms of engagement.
5. All students become more disengaged over time, but non-persisters in engineering disengage more quickly.

NSSE and MIDFIELD data are consistent. Patterns of enrollment, engagement, and persistence of engineering majors are, in fact, similar to those of other majors. Like Seymour and Hewitt (1997), we find that students who start in engineering resemble other students in terms of their engagement in, and outcomes from, their college education. However, we have a lot more to learn about how students come to "own" a particular major. The current work shows that looking at this question for a variety of majors is likely to provide greater insights than single-field studies about the processes involved in choosing a major and about how students can be better supported by institutional practices.

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