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Introducing a Virtual Dashboard to Benchmark and Monitor Engineering Graduate Degree Retention Trends at Penn State

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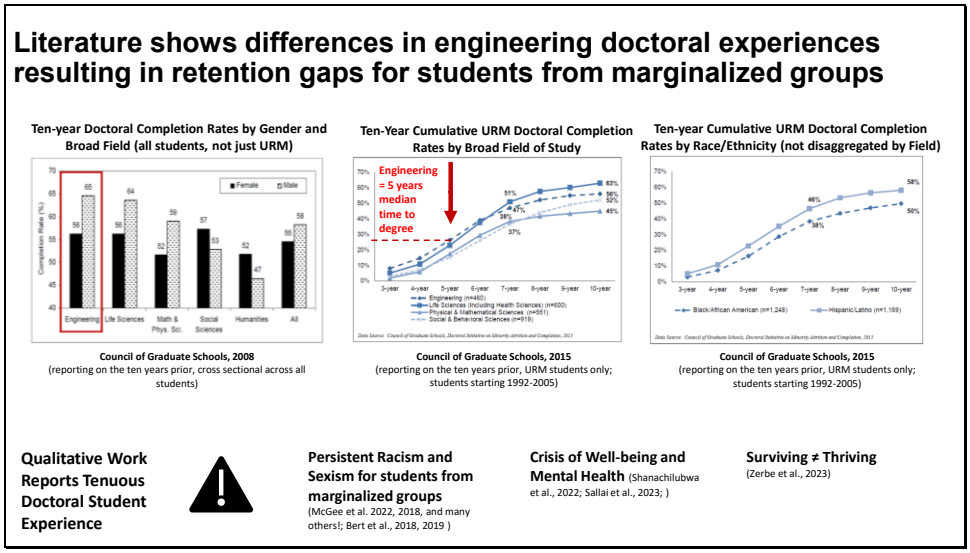
Slide 1

Note: Target is 2 minutes per slide plus time for Q&A

Slide 2



Recently, doctoral attrition and persistence has become a more pressing issue, bolstered by two relatively recent reports by the National Academies on graduate education and graduate wellbeing in 2018 and 2020. Since then, in engineering education, slightly more attention has been paid to doctoral education, capturing the often deleterious experiences that graduate students face. Qualitative research has been useful for capturing the nuances in graduate student experiences, and the work of many research groups shows how systemic racism and sexism continues to affect graduate students' well-being. It is not difficult to link poor experiences in graduate school with attrition considerations, and recent literature conducted immediately after the pandemic shows that a large majority of students consider leaving their PhD at some point, even if they end up persisting. However, it is extremely difficult to capture national benchmarking data because there are no formal centralized ways to capture standardized metrics. The most comprehensive national statistics in the United States come from the Council of Graduate Schools in 2008 (for the general graduate student population) and 2015/2018 reporting on a similar nationwide study of graduate students from historically marginalized groups. Each of these studies investigated cohorts of students from the ten years prior, and have not since been repeated. In sum, these studies show that even for the disciplines of engineering, which boasts a relatively short time to degree completion and a relatively high "ten-year completion rate" the numbers of students graduating after ten years is still very low, representing a loss of talent and resources. Further, the arbitrary definition of a ten-year completion rate raises some concerns, given that many graduate programs have limits on graduate study that are lower than that, and that the median time to degree completion in engineering is about five years. These numbers also show that there are steep differences in the completion rates of graduate students from historically marginalized populations compared to students from historically well-represented groups.

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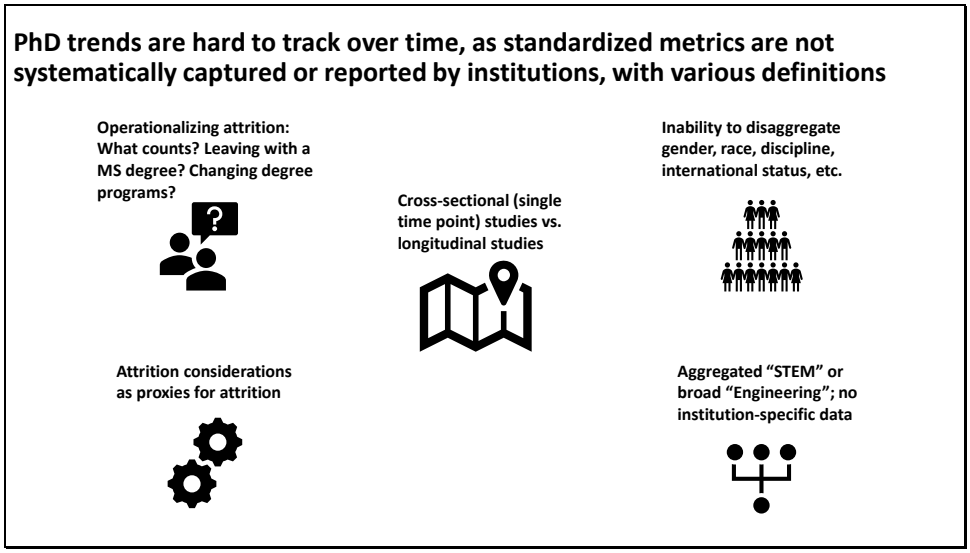
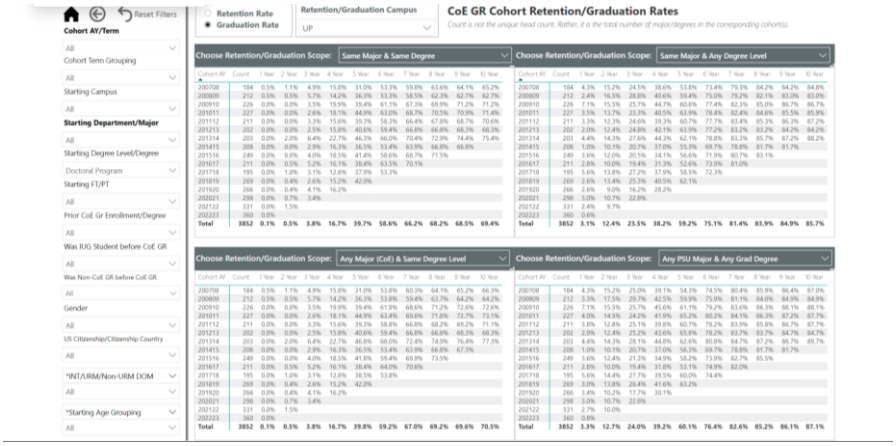


While the CGS studies do represent the largest and most comprehensive study, they only represent students from 21 universities across the United States. Further, the publicly available reports do not disaggregate by gender, race, and discipline or subdiscipline in ways that might be useful to govern university or college-level policies. It is very easy to sweep issues under the rug if they are not monitored or able to be identified in a particular university, college, or departmental context: If the problem isn't measured, then it doesn't exist! And, most universities do not longitudinally track graduate student retention and demographic data with the degree of detail required to watch year-over-year trends, measuring potential discrepancies between student groups. Since each institutions is left to collect and track their own students, it is unclear if and how these data, if collected, are used. There are also any number of ways to conceptualize topics related to attrition: For example, if someone starts in one program, and ends in another, does that count as persistence? If the transition is not captured, how can we identify whether there are persistent cultural problems? As another example, are students who leave their PhDs with a master's degree captured as a degree completion, or as a sneaky form of attrition? Across studies, there are several persistent issues that inhibit the ability to fully characterize attrition: The operationalization of attrition, as discussed; the limitations of cross sectional studies that aren't repeated to see new generations of graduate students given changes in economic factors; the inability to disaggregate between gender, race, and discipline (or subdiscipline) because of identifiability issues; the typical aggregation of all "STEM" students together in high education, and the fact that often studies investigate students' attrition considerations rather than actually capturing attrition. These are outstanding issues for the community to continue to investigate in research and practice, but, to this end, the purpose of this paper is to highlight current efforts at our university to collect and track student metrics, with the ability to disaggregate at any level of detail, as ways to stay accountable and watch progress over time.

Slide 4

In this presentation, we document a novel dashboard to track longitudinal trends in doctoral attainment and attrition across a College of Engineering



We use PowerBI to gather and curate data on student identity, enrollment, and outcomes. The dashboard allows sharing of data across the college, including graduate program chairs and faculty and staff charged with supporting graduate student success. The dashboard enables multiple views, including cohort overviews, cohort overviews disaggregated by previous degree program, tables of retention and graduation rates, and overviews of time to degree. The dashboard enables tracking of retention and graduation for students with different paths, such as switching degree programs or discipline within the College of Engineering or anywhere in the university.

The data encompasses cohorts from 2007-present. The necessity of curating data requires collection and analysis, which is handled by the data and assessment team in the College of Engineering. Data from future cohorts will be entered yearly, to enable continued assessment and reflection.

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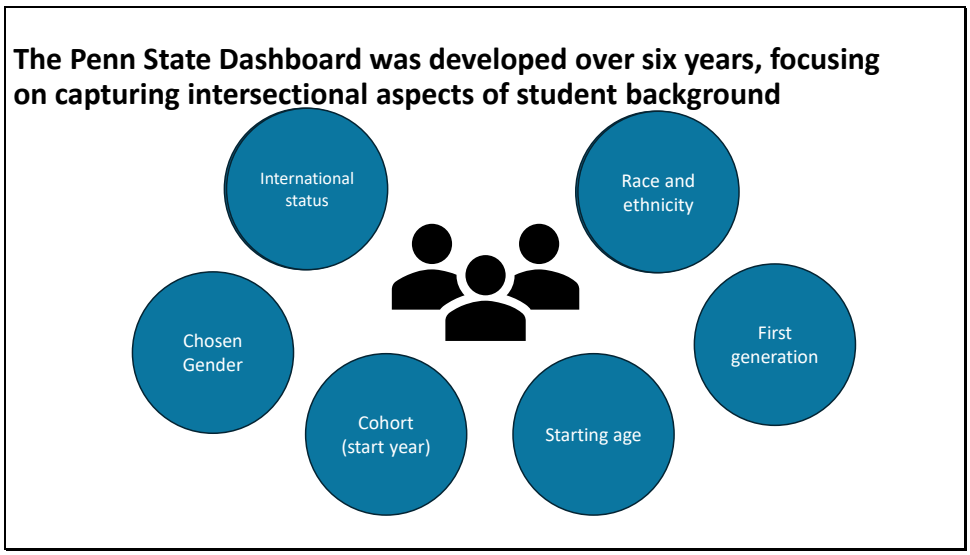

Given the persistent gaps in recruitment and retention of graduate engineering students from marginalized racial/ethnic and gender backgrounds, the purpose of this presentation is to introduce a novel dashboard initialized by the College of Engineering at Penn State to understand 10-year completion and attrition statistics, able to disaggregate between myriad student profiles. This ability to disaggregate data separates and provides a utility differently than other publicly available data; often, data are grouped either by gender *or* race; and master's and PhD students are often lumped together. Our dashboard enables us to track students in terms of various identity profiles for each graduate program or the entire college as a whole. All data is anonymous, and no student identifying information Is included.

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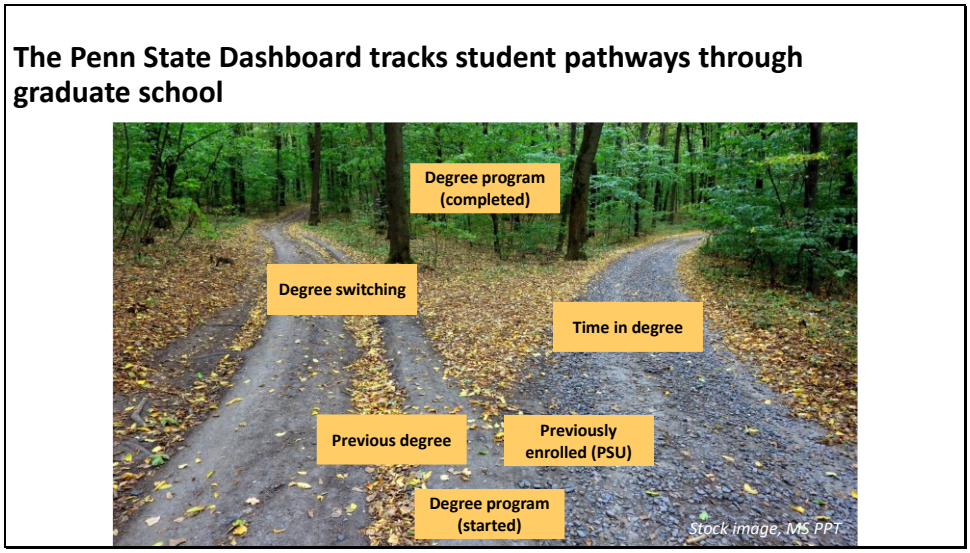

Further, our dashboard offers the opportunity to map degree completion from intended program, capturing trajectories of students who changed from a PhD to a Master's degree, and those who completed degrees in programs different than their original programs of study. These are nuanced forms of departure and attrition in graduate school that are rarely captured. The ability to track previous degree status, such as whether the student already held a Master's degree prior to starting a PhD program, enables us to ask specific questions about how student trajectories correlate with student success. Coupled with disaggregation with student identity, we have a powerful tool for assessing our graduate programs and learning about our students.

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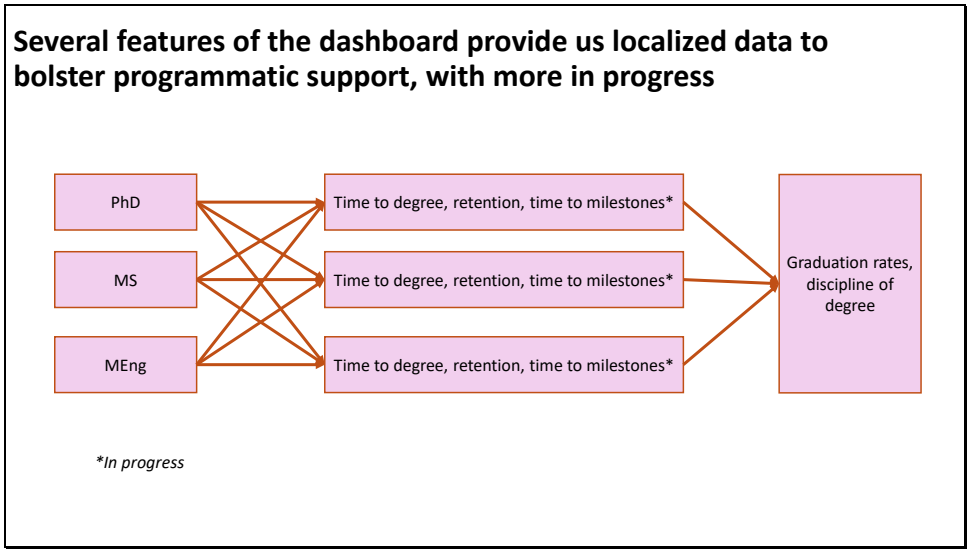

Our dashboards enables to track student progression through graduate programs at Penn State. For example, we can track how students that enter as PhD students progress within their program, and remain within the PhD track or move to an MS/MEng track. We can also track their time to degree depending on their trajectory. Future work will also incorporate time to milestones, which includes time to successfully passing qualifying and comprehensive exams that are needed for progression towards a PhD. As mentioned previously, we can track these metrics for students that have started their graduate program with a previous graduate degree, such as students that start a PhD program at Penn State with an MS. Given that some programs require progression to a PhD by first obtaining an MS, we also track whether the MS was obtained at PSU or not. Such information, coupled with the ability to disaggregate based on program, enables tracking of student progression within the context of the disciplinary norms and requirements.

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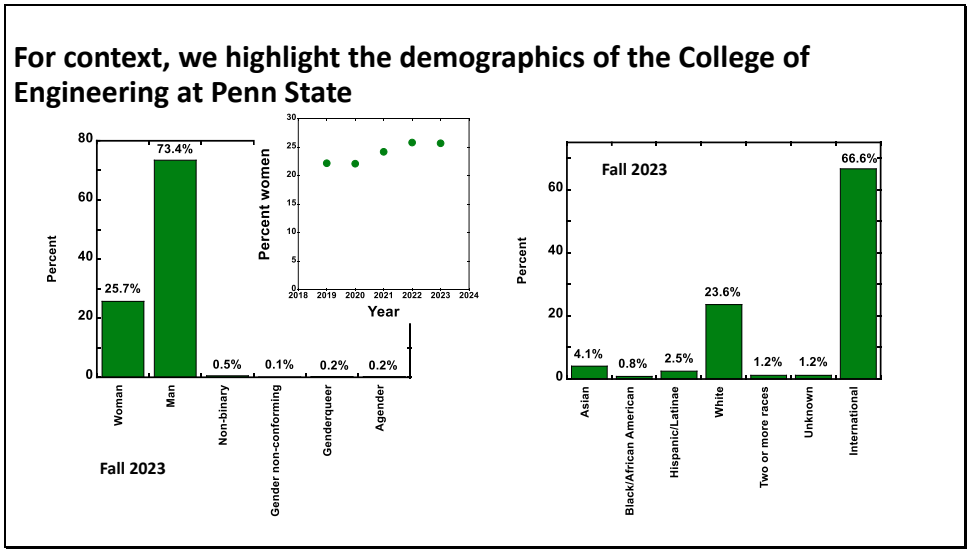
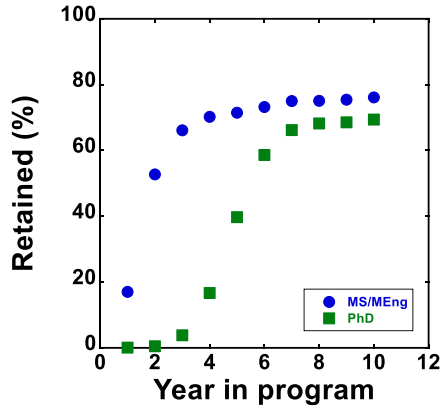


Before discussing the data and trends observed from our dashboard, we show some of the demographics of graduate students in the College of Engineering at Penn State. Most graduate students identify as male, although other gender groups, such as women, non-binary, gender non-conforming, genderqueer and agender have been growing modestly over time. We show the percent of women-identifying students as a function of year, which shows a small increase from about 22% to almost 26%. We also show the race and ethnicity of graduate students in the College of Engineering at Penn State. Penn State only tracks race or ethnicity for domestic students, so In this same plot we show the percent of students that are international. The majority of graduate students are international, with most identifying as white. We define underrepresented students as those that identify as Black/African American or Hispanic/Latinae. This would also include any American Indian, Pacific Islander, or Hawaiian or Alaskan native, although this number is zero for the College of Engineering at Penn State. Although some of these demographics have also changed over time, these changes have also been modest, and we only show data recorded in the fall of 2023 to provide a snapshot of graduate student identities at Penn State.

Slide 9

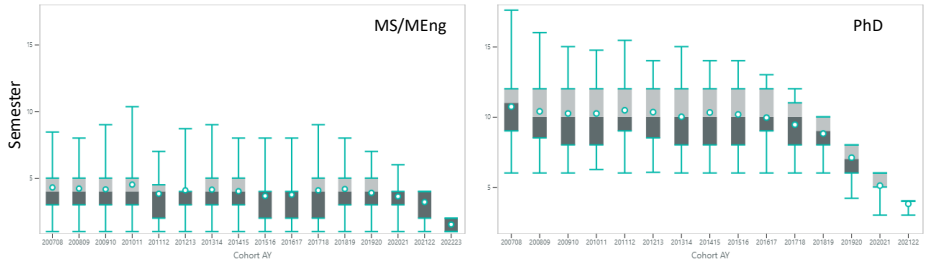
The overall retention rate for graduate students within the College of Engineering can be disaggregated based on degree program



We compare the completion rates for students that started in a Masters program or a PhD program. Here, the data is shown for students that completed their degree within the same discipline and same track (Master's or Doctoral) as they started. The overall completion rates are similar to rates observed in the literature, where about 70% of Master's students complete their degree within 3 years, and 76% within 10 years, while 69% finish their PhD degree within 10 years. The difference between 3 and 10 years for Master's degrees is not necessarily due to long graduate studies duration, but instead is likely arising from differences in averaging over multiple cohorts. We can also observe this trend in time to degree data, as we will show next.

Slide 10

We can examine time to degree for different tracks, which show averages that have changed little with time

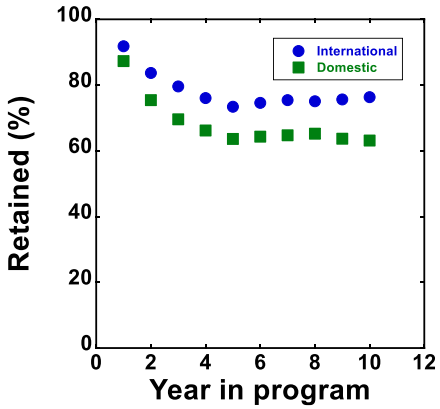


Completed degree within same discipline and same degree track as started
Cohorts: 2007-2022

We compare the time to graduation for students seeking Master's degrees or PhD degrees. Here, we track students that obtained their degree within the starting discipline and track. On average, Master's students complete their degrees in about 2 years, and this average has not changed much with time. For PhD students, the average is about 5 years, and is relatively steady with time as well. Here, averages are reported as the median. The boxes show 25% quartile and 75% quartile, while whiskers show the 5% and 95% of the distribution. The substantial distribution shows some students take long times to achieve their degrees, with respect to the median for each track.

Slide 11

We can track the retention of doctoral students disaggregated based on their country of origin



Start as PhD students,
retained in same program
and PhD track
Cohorts: 2007-2022

Our dashboard tracks country of origin for students in our graduate programs. Here, we show retention data for domestic students (US citizens or permanent residents) and students from outside the US. These students started as PhD students. We show the data as percent retained within the same graduate program, and in the PhD track. Students show a substantial, rapid attrition within the first few years of their program, with the largest drop in between years 1 and 2. International students have a higher retention rate, with an average 76% 10-year retention rate, while for domestic graduate students the 10-year retention rate is 63%. The data is averaged for students that started between 2007-2022. Not all data is available for all cohorts, such as the slight uptick with year in program is likely due to averaging between cohorts, and the variability of retention between cohorts.

We do not have a clear explanation of why international graduate students are more likely to be retained at Penn State. It is possible that a vibrant, multi-national community within the College of Engineering leads to a supportive culture that supports student success. It is also possible that international students face a stronger pressure to remain (and complete) their graduate program due to Visa issues.

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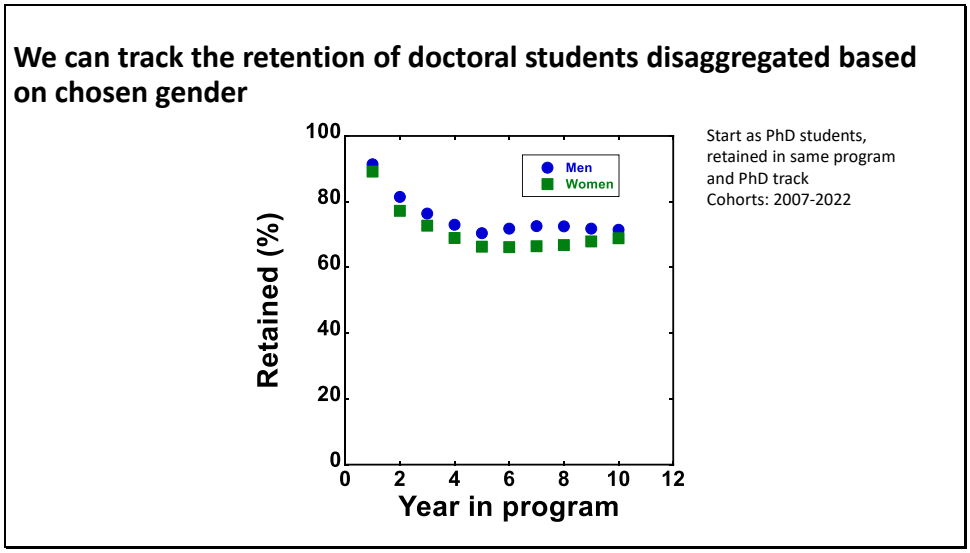

We can also track our retention rates for doctoral students for students of different genders. Here we show retention versus degree program for students that started in a PhD program and remained within the same PhD program. Retention rates are consistently slightly higher for men than for women, although the differences are small. After 10 years, 69% of women are retained (or graduated), while 72% of men are retained or graduated. This gender equity gap in graduate student retention needs to be addressed within the College of Engineering at Penn State.

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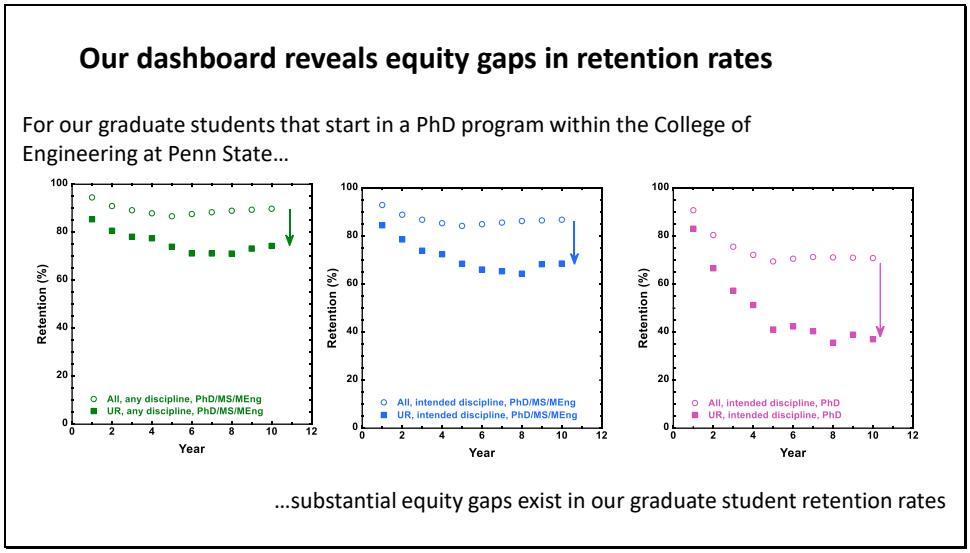

These graphs show the retention rates over time for students starting in a PhD program at Penn State that is available through our recently developed custom dashboard.

Data is shown for students that start in a PhD program in the College of Engineering at Penn State, and are retained for any discipline at PSU and any degree (green). This includes students that might have switched intended discipline or department or degree program (for example, switched to a Master's track). After 10 years, about 90% of all grad students are retained (or graduated) within any program at Penn State. We also track these data for students from underrepresented groups, which here includes students that self-report as black, African American, Hispanic, Latinae, American Indian, Native Hawaiian or Pacific Islander. Students from these populations are retained at a lower rate, of about 75%. The blue data in the middle graph shows retention within the starting discipline or program but for any degree (PHD or MS), where now retention rates are slightly lower, about 87% for all students and 69% for underrepresented students. The equity gap persists. The data in purple is for graduate students that started as PhD students, and remained within their PhD program and in their intended PhD track.

Arrows highlight equity gaps. N = 3852 for All and N = 130 for UR, 2007-2022 cohorts (data not available for all cohorts).

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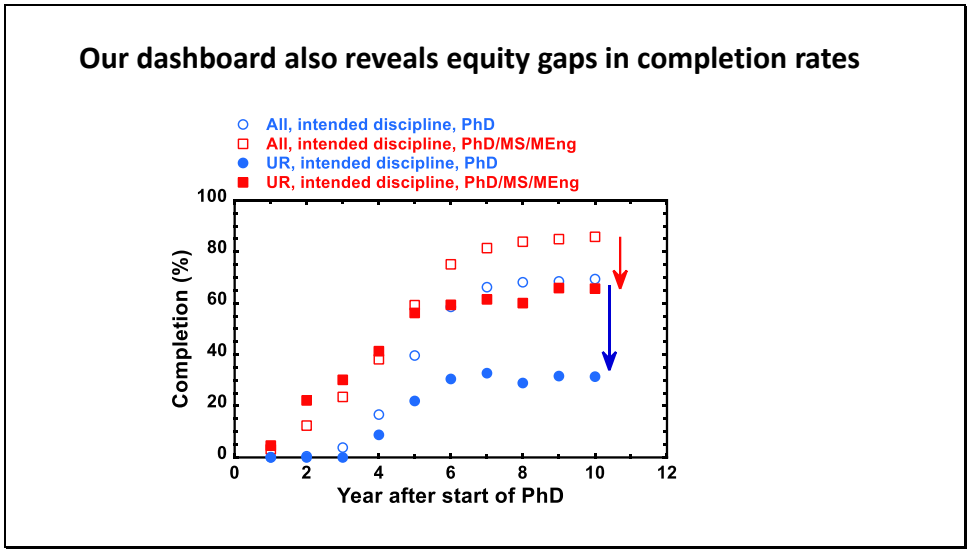

Another way to look at our equity gaps is by tracking graduation or completion rates for all students and underrepresented students. Here, we track doctoral students that go on to complete their degree within the program they started in and the same PhD track (blue) or within any track but the same discipline (red). Thus, we show completion rates over time for all (All, open symbols) and underrepresented (UR, closed symbols) students starting in a doctorate program at Penn State that is available through our recently developed custom dashboard. The data shows that most students finish within about 6 years of their start of their degree. The arrows highlight equity gaps, where we see a substantial lower graduation rates for underrepresented students, of about 30% after ten years, compared to almost 70% for all students that started within a doctoral program and completed their PhD. The equity gap is smaller when we consider graduation in any degree track, but within the same discipline, where about 65% of underrepresented students graduate with an MS, MEng or PhD, while the average graduation rate for all students after 10 years is about 85%. Here, N = 3852 for All and N = 130 for UR, and data is included for 2007-2022 cohorts (all data not available for all cohorts).

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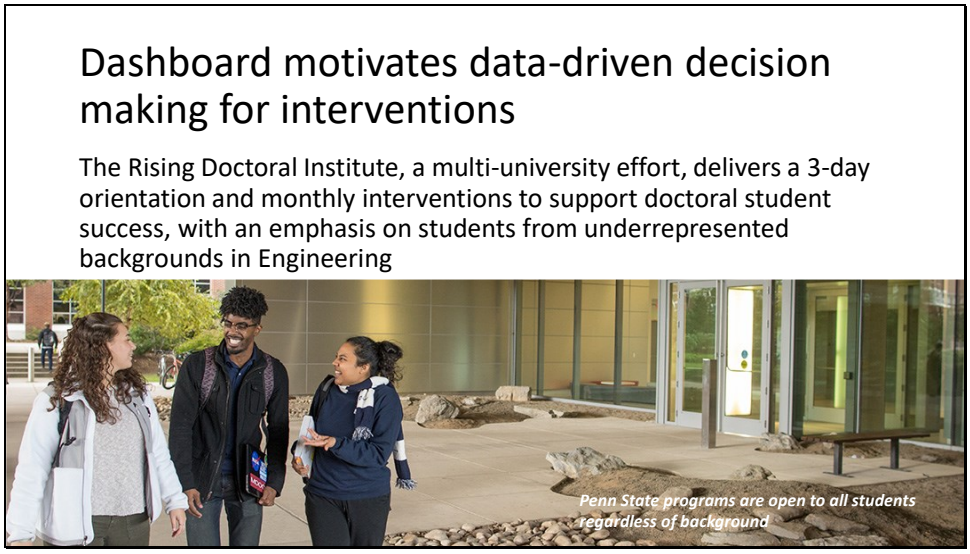

The graduate retention and completion dashboard enables us to identify equity gaps, as we have shown, and thus implement interventions to address these gaps. One such example is the Rising Doctoral Institute, which aims to students to successfully navigate their degree programs and provide a network of support at Penn State. The Rising Doctoral Institute is currently led by a multi-university effort, including Arizona State, Rowan, UT Dallas, and Virginia Tech. This program leverages evidence-based approaches to provide students a 3-day orientation and monthly meetings aimed at building networks, enhancing awareness of resources, providing professional development, providing tips for technical communications (including writing and presentations), helping manage adviser relationships and expectations, providing mental well-being resources, and providing mentorship opportunities. This program is open to all graduate students, but emphasizes students from backgrounds underrepresented in STEM.

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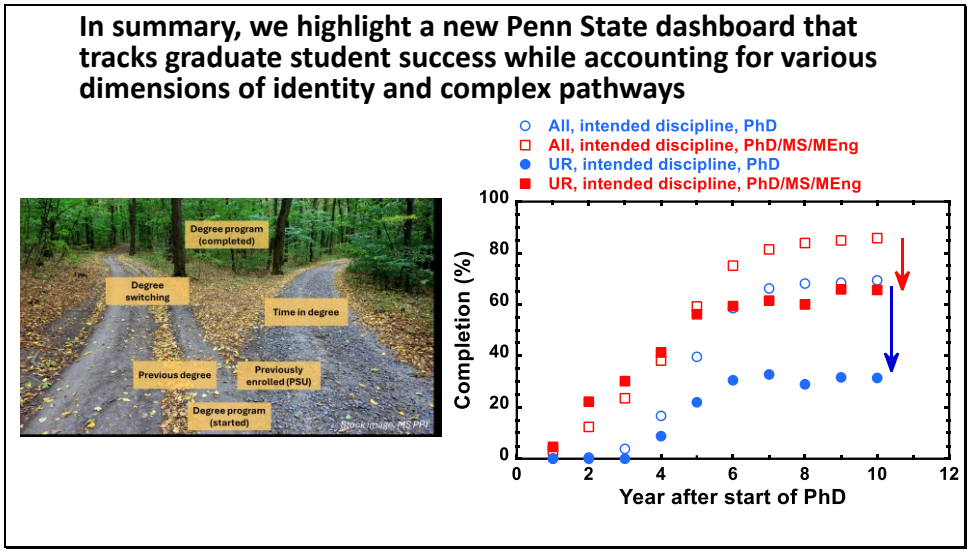

In summary, we aim to contribute to the ongoing discussion of graduate retention and completion, in particular as it relates to students from various identities and different pathways. We believe that the ability to track intersectionality, both in terms of identity but also in terms of degree background and path, is crucial to identify potential challenges that graduate students face. For example, here we have shown that a modest gender equity gap exists within the College of Engineering that must be addressed. We also show a large equity gap between students of different race and ethnicity, regardless of whether we consider doctoral students that graduate with any degree or only with their intended PhD program. We hope that highlighting these data curation efforts emphasize the need to track the complex interplays of graduate student pathways, to help us all identify needs within our institutions and motivate the allocation of effort and resources towards closing persisting equity gaps in engineering graduate education.