Gatekeepers to Broadening Participation in Engineering: Investigating Variation Across High Schools Comparing Who Could Go versus Who Does Go into Engineering

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This project is an investigation of the gatekeepers—including the people, places, programs, and policies—that contribute to demographic variations across high schools in the proportion of students who enroll in an engineering major at a four-year university. Our research takes a macroscopic, systemic view of an entire state's longitudinal database of high school-to-postsecondary student records to understand how high schools perform in terms of having its students who fit an engineering academic profile *choose to enroll* in an engineering postsecondary program. Enabled by an administrative state-level data set, we investigate variation across high schools for the following underrepresented populations within engineering: women, African Americans, Hispanics, students from a low socioeconomic status (SES), as well as students from different school contexts (i.e., geography and population density).
In addition to understanding *where* there is variation, we also are seeking to understand *why* certain high schools across the state have higher engineering yields than others. Even within the same school districts, our quantitative data demonstrate high variation, and the second phase of our research focuses on purposefully selected districts and high schools to investigate that variation. Guided by social cognitive career theory, our qualitative data collection unpacks, from high school administrator and teacher perspectives, the complex interactions between students' goals, interests, and self-efficacies, which are informed by a variety of contextual influences and learning experiences. Importantly, our project focuses on a specific section of the pathway to an engineering career and explores variation across subpopulations and local contexts. Moreover, rather than focusing on single interventions, we frame our research holistically to understand how the variety of potential gatekeepers might be re-positioned or trained to support a more diverse population of students who choose to enroll in postsecondary engineering programs.
The overarching research question that we seek to answer is as follows:
Where and why are there demographic variations across high schools in the proportion of students who fit an engineering academic profile but do not enroll in an engineering major?

We break that question into the following sub-questions:

1. How do the academic profiles of Virginia high school students who enroll in four-year postsecondary engineering programs vary across and within Virginia high schools?
2. For each school, a) what is the ratio of students who fit an engineering academic profile and choose to enroll in engineering programs versus those who fit the profile and choose a non-engineering major, and b) how does that ratio vary across demographic characteristics, especially race/ethnicity, gender, family SES, and school context?
3. What local and contextual factors contribute to the variation in ratios between high schools and across demographic characteristics?
4. How do students and gatekeepers align in their perceptions of influences on students' interest in enrolling in a four-year engineering postsecondary program?

Summary of Preliminary Project Results

Our quantitative analysis demonstrates that the rate at which students enroll in engineering differs across high schools. While we show a relationship between the number of high school completers (i.e., class size) and the percent of students who enroll in engineering, it is less pronounced than the relationship between number of completers and four-year college-going. Thus, we assume that there are other factors at play that push students toward or away from engineering. As we demonstrate on our poster, our results also show very different patterns across demographic groups and demonstrate that Virginia has much room for improvement in expanding the share of four-year female college attendees who enroll in engineering. Although still below the state average, the share of four-year underrepresented minority and economically disadvantaged attendees who enroll in engineering is larger than the share of female attendees, despite females having a higher percentage of four-year college attendees than males overall. Thus, our results suggest different strategies may need to be implemented across subpopulations when seeking to broaden participation in engineering.

Both the quantitative and qualitative results point to variation between but also within school divisions in engineering yield. Considering this "gatekeeper" problem at the level of school divisions (or counties) would lose much of the variation in engineering-going between schools. We recommend keeping analyses at the individual high school level.

Selected Quantitative Results

Much of the work in the first phase of this project has focused on quantitative analysis, addressing the first research question. To complete such analyses, we draw on data connected and consolidated by the Virginia Longitudinal Data System (VLDS), which brings together individual-level data across the Virginia Department of Education (DOE), the State Council of Higher Education for Virginia (SCHEV), Virginia's Community Colleges, and the Virginia Employment Commission, among other agencies. The system de-identifies individuals, but a single individual's data can be tracked across the suite of agencies. We focus specifically on the Virginia DOE and SCHEV data sets so we are able to track students' high school to postsecondary enrollments.

For these analyses, we flagged all Virginia students who completed high school in the 2008-2010 academic years using the DOE student records data table and were present in either the National Student Clearinghouse (NSC) or SCHEV data sets (n=162,449 students). Additionally, we flagged students by the following demographic variables: female, underrepresented minority, and disadvantaged status (i.e., eligible for free/reduced meals, receives Temporary Assistance for Needy Families (TANF), eligible for Medicaid, identified as migrant, or experienced homelessness). Next, we focused our analyses on students who enrolled in a four-year institution within at least four years of high school completion (n=77,131). Finally, we flagged students who enrolled in an engineering or computer science program at any point in their enrollment in their four-year university (n=5,042 students, approximately 6.5%). For students who enrolled in a Virginia university, we used the SCHEV data tables because of its more complete data quality. For students who enrolled in a university outside of Virginia, we used National Student Clearinghouse data, which is included with the DOE tables in the VLDS.

Our first set of analyses explored the enrollment rate as a function of number of high school completers by high school for all students (see Figure 1). To establish a baseline, we first investigated the four-year college going rate for the completers (see top plot; students who dropped out of high school were not included). Across all high schools in Virginia, the average four-year college going rate of high school completers was 43.72% (the horizontal line on the top plot). The blue line in the figure represents a line of best fit of four-year college-going rate regressed on number of high school completers, and the dotted line represents a Lowess smoother that helps illustrate the pattern in the data. In general, as schools increased in size, the percentage of completers who attended a four-year institution also increased in size. In Virginia, many of the larger schools are concentrated in areas with large sources of social and cultural capital, such as the northern Virginia area, which likely explains this pattern.

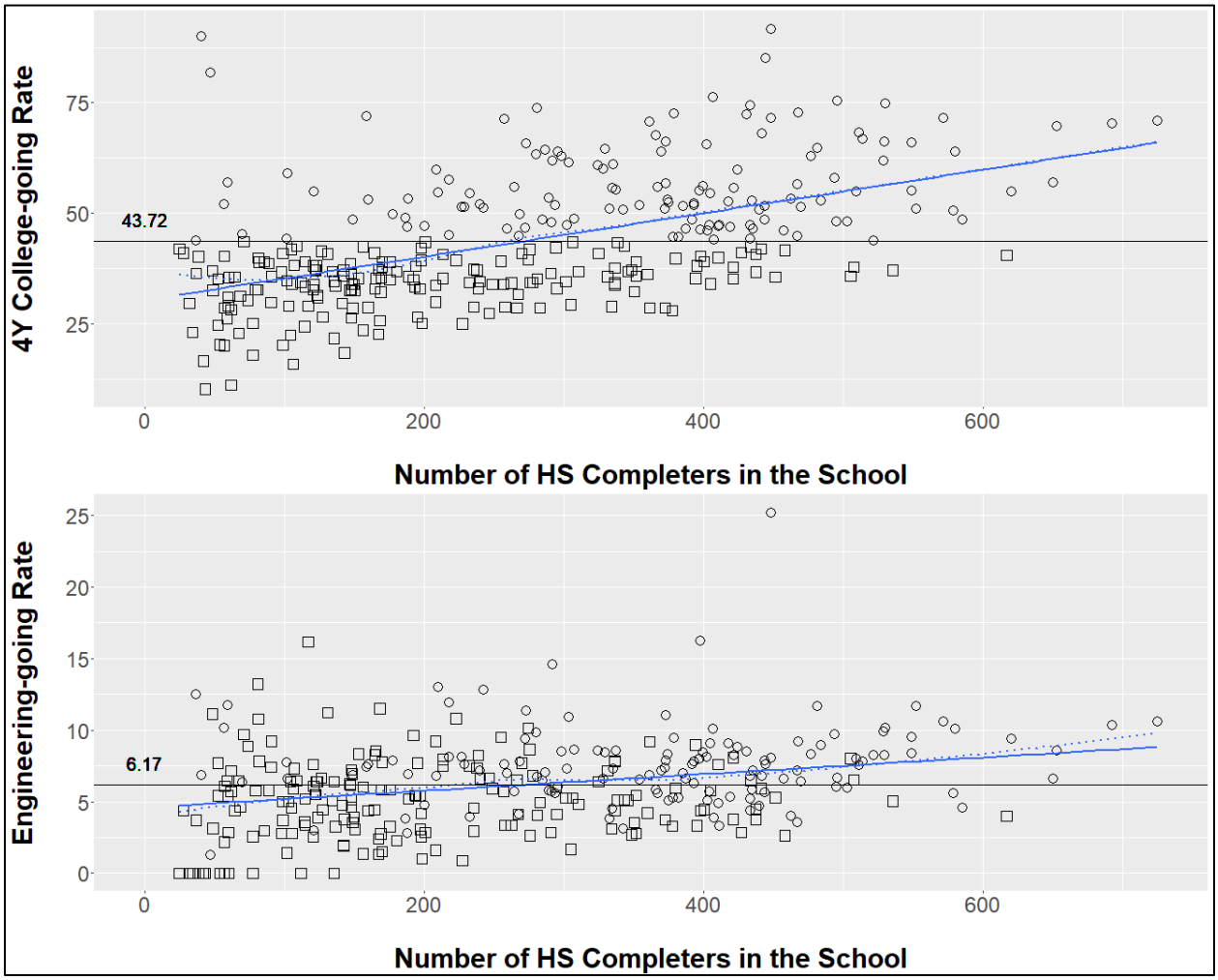

Figure 1. Top: 4-year college going rate as a function of number of high school completers by high school. Bottom: Of the four-year college-goers, the engineering/computer science enrollment rate by high school completers.

Of those who attend a four-year institution, the average that enrolled in engineering or computer science was 6.17% across Virginia high schools, with values ranging from 0% to over 25% (see bottom plot). High schools are ordered along the same variable (number of completers) on both

plots; note that points above the state average in the top plot are circles and the points below the state average are squares. In comparing the two plots, we observe that a different phenomenon occurs within engineering. First, schools below the state average in the top plot (four-year going rate) are above the state average on the bottom plot (engineering rate) and vice versa. As we see in the bottom plot, there are several small schools that have a high engineering-going rate. Second, we observe a stronger relationship in the top plot (r^2=0.29) compared to the bottom plot (r^2=0.08). Thus, the relationship between number of completers and enrollment in engineering is less strong than it is for four-year college enrollment. In summary, our analyses show that although we observe a positive relationship between engineering enrollment and school size, it is less pronounced than for four-year attendance, and there is a high level of variation across Virginia—small schools have above- and below-average percentages of students who enroll in engineering and thus different phenomena must be driving engineering enrollment. We extend these analyses for each demographic group and present those findings on our poster.

Selected Qualitative Results

Through the qualitative phase, we seek to understand why these variations exists within and between counties. During this first year, the team identified potential case sites and types of participants within those sites (principals, teachers, career counselors), developed data collection instruments, and began data collection. The research team selected three case sites to investigate guided by the preliminary quantitative results specifically with regard to contextual influences on students' decisions to pursue engineering or not. We next parsed the data for percent enrollment in four-year college, engineering enrollment, and by demographic group to select initial specific high schools within the case sites. We developed semi-structured interview protocols based on our framework and to explore and explain differences through the quantitative results regarding percentages of students attending four-year universities and percentages going into engineering. With regard to data collection, we have interviewed principals, guidance counselors, and teachers within one case site (i.e., a region) and we are preparing to start the second site. Our initial analysis shows similarities and differences in how the principals talk about post-secondary education in general, which students are likely to pursue engineering and why, and comparisons between themselves and other schools in the district. Prevalent across the data from the first site is a theme of wanting to support students. However, the principals' apparent expectations of students and how to best support them varied by school. For example, the principals talked differently about a county-wide initiative to financially assist students for college. The principal at one high school, which is close to a 4-year university, stated the program could benefit students who may otherwise be left behind. A principal at a different high school in the same county stated a hope that the program may allow more students to go to community college. We will continue to collect and analyze qualitative data from our three case sites.

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