What Matters for STEM Degree Completion?

Expanding and Diversifying College Graduates

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Purpose

As the European Union and China begin to outpace the U.S. in the production of scientists, the U.S. government has stepped up efforts to review and reinvest in programs and policies related to undergraduate education in science, technology, engineering, and mathematics (STEM). This study examines the effectiveness of such programmatic and policy initiatives as they are implemented at an institutional level. Using multilevel modeling, we examine how institutional programs and policies, as well as student background characteristics, together affect STEM completion. In particular, we examine how institutional structures of opportunity mitigate or enhance the impact that students' background characteristics have on STEM completion.

Data

Three Data sources:

- Initial student-level data: 2004 CIRP Freshman Survey
- Student degree completion data: 2009 National Student Clearinghouse
- Institution-level data: 2009 Best Practices Survey

Sample:

- 55,178 STEM aspirants across 237 institutions
  - Students: 47% Female; 10% Black, 7% Latino, 2% Native American, 13% Asian American, 65% White
  - Institutions: 78% private; 4% HBCUs; average selectivity 1140

Missing Data:

- Multiple imputation for missing data

Prior Literature

Success is determined by more than a combination of individual ambition and prior success—institutional opportunity structures matter as well.

- Three most important student-level predictors of STEM degree completion:
  - Rigorous high school curriculum
  - High standardized test scores
  - Strong grades in high school
- However, even after accounting for variability in the above characteristics, differences in STEM completion across racial/ethnic groups persist.
- Institutional context matters
  - STEM degree completion likelihoods for under-represented racial minority (URM) students are highest at minority-serving institutions, particularly HBCUs
  - Selectivity (average SAT scores) has mixed effects
    - Higher degree completion rates across all majors at high selectivity institutions
    - Lower STEM degree persistence for URMs at high selectivity schools

Analyses

Analytic Strategy

- Hierarchical generalized linear modeling
  - Four successive models:
    1) Institutional predictors only, without selectivity
    2) Institutional predictors only, with selectivity
    3) All institutional predictors and individual-level predictors
    4) All institutional and individual predictors, with the effect of Black allowed to vary across institutions
  - Significant results discussed in terms of change in likelihood of earning a STEM degree vs. degree in non-STEM field, or earning a STEM degree vs. no degree

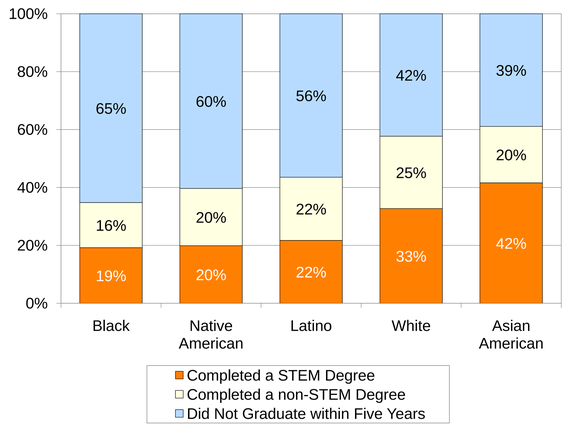
Dependent Variable

- Three category outcome, measured five years after matriculation:
  - Earned a degree in a STEM field, Earned a degree in a non-STEM field, No degree earned

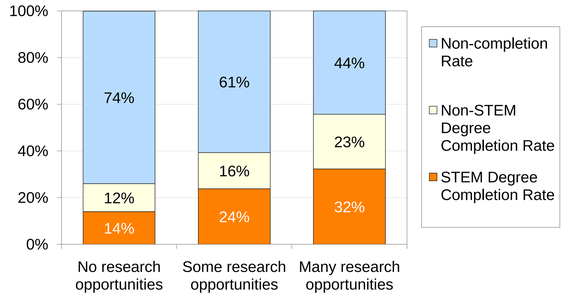
Independent Variables

- Individual-Level Predictors:
  - Academics (high school grades, SAT scores, high school academic activities); Demographics/Background (race, sex, SES); STEM identity; STEM career aspirations
- Institution-Level Predictors:
  - Institutional characteristics (selectivity, HBCU, control); STEM programming/policies (undergraduate research program(s), undergraduate STEM retention initiatives, formalized opportunities for faculty mentorship of students)

Five-Year STEM Degree Completion, by Race



Five-Year STEM Completion Rates by Extent of Institutional Research Opportunities



Results

Key Institution-Level Effects

- Model (1), without selectivity:
  - **Undergraduate Research Programs**: Offering these programs increased average institutional STEM completion rates (compared to rates of earning no degree)
  - **STEM Retention Programs** for all students: Offering these initiatives increased average institutional STEM degree completion rates (compared to non-STEM degree completion rates)
- Model (2), with selectivity:
  - Undergraduate research programs and STEM retention programs were no longer significant predictors, as adding selectivity to the model accounted entirely for the effect of the programmatic interventions that institutions offered
  - **More selective institutions** had significantly higher STEM completion rates than less selective campuses (compared to rates of degree non-completion)

Key Individual-Level Effects

- Model (3), with all institution and individual-level effects:
  - **High school GPA**: Higher HS GPAs were associated with significantly higher rates of STEM degree completion, relative both to earning a non-STEM degree, and to earning no degree
  - **High school math**: Every additional year of HS math completed increased the probability of earning a STEM degree, relative both to earning a non-STEM degree and to earning no degree
  - **Race**: White students had significantly higher probabilities of earning a STEM degree (vs. no degree) than did students who were Black, Latino, and Native American
- Model (4), with effect of Black allowed to vary across institutions:
  - **Black students in HBCUs** were much more likely to complete a STEM degree (vs. no degree) than their Black peers in PWIs

Implications for Practice

Undergraduate research opportunities:

- Expand undergraduate research opportunities
  - Currently primarily funded by external agencies, but need not be
  - Encourage faculty to include undergraduate students on their research projects (see Eagan et. al., in press)
  - Target funding at lower-selectivity institutions, which are less likely to offer research opportunities

Other research-related opportunities:

- In addition to research involvement, identify opportunities for undergraduates to present their findings at conferences or publish their results
  - Descriptive comparisons suggest significantly higher STEM completion rates at campuses that offer these opportunities

Identify what makes research opportunities work:

- Qualitatively investigate STEM retention programs on campuses that offer them
  - What specifically are these programs doing to retain students?
  - What practices from these programs can be adopted or scaled up across other campuses?

Next Steps

- In the future, we plan to:
  - Collect and analyze six-year completion data
  - Conduct separate analyses by race
  - Conduct separate analyses by academic discipline
  - Create an interface to enable campuses to calculate expected STEM completion rates

Project Team

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