

The Effect of Early Undergraduate Research Experiences on STEM Degree Attainment

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Purpose

This study examines the impact of Early Undergraduate Research Experiences (Early URE) on students' retention in postsecondary STEM majors, particularly for those traditionally under-persisting in STEM (e.g., women, first generation students).

Intervention and Research Design

Early URE programs have been proposed as a strategy to increase students' interest and persistence in STEM and to broaden participation in these disciplines. This is especially so within research universities which house many ongoing research projects, offer challenging, large-lecture introductory coursework, and often suffer a visible lack of diversity within STEM trajectories. The program which we investigate is offered at a mid-sized public research university. The program was designed for second-semester, first-year students to experience a during-the-term authentic research experience. Participating students are expected to devote 5 to 10 hours per week (1 or 2 credit hours) to the research project mentored within a faculty member's lab.

Students are recruited for the program during the fall semester, prior to receiving final fall semester grades. They are matched to faculty for interviews on the basis of their resume and interests. Prior to the end of the fall term, faculty members select students to accept, and students make the final decision to enroll.

We use Coarsened Exact Matching (CEM) to contrast outcomes of students who enrolled in the Early URE experience to those of an observationally similar matched set of students who did not enroll. Please note that we are awaiting additional data on the full set of students who have applied to the URE program. This will allow us to strengthen our analysis by matching both applicants and participants to observationally similar students and conducting a difference-in-differences analysis to estimate program impacts. We expect that these analyses will be complete in time to present at the conference.

Data Collection and Analysis

We utilize institutionally-provided data on 12,883 students (1,426 who participated in an Early-URE and 11,457 who did not) across 8 first-year cohorts to examine the effects of the program on students' STEM retention. We limit the sample to those first-year students who enrolled in an introductory science course during their first semester.

We drew matched counterparts for program participants using coarsened exact matching (CEM) using the following variables: 1) demographic factors reported in the literature as important for university achievement (e.g., gender, ethnicity, first generation status) (Jacobs, 2005), 2) academic factors relevant for science learning (STEM Advanced Placement exams, SAT scores) (Camara, 2000; Goldstein, Haldane, & Mitchell, 1990; Rohde, Rohde, Thompson, & Thompson, 2007), 3) policy-relevant high school characteristics (e.g., school urbanicity, public vs private) (Legewie & DiPrete, 2014), and 4) cohort year and first semester university GPA (as this is an important predictor of future university performance). CEM exactly matches individuals on a set of "coarsened" variables (numerical variables divided into two or more meaningful ranges or categories). This approach to drawing causal inferences also allows for an examination of how this intervention differs in effect by matching variables (e.g., is the intervention more effective for males or females). We then compare the URE participants and their matched counterparts on several outcomes, including third semester retention, degree completion, and completion of a STEM degree (See Table 1 for matched sample results).

Table 1. CEM matching sample results

	Didn't Take Early URE	Took Early URE
All	11,457	1,426
Matched	1,284	674
Unmatched	10,173	752

Findings

To test the effectiveness of our matching, we used the L1 imbalance metric (see Table 2). This metric measures the difference in multivariate histograms of treated and control groups (Lacus, King & Porro, 2011). When comparing the imbalanced vs the matched sample we can see that all differences between groups on the covariates of interest have been eliminated.

Table 2. L1 Imbalance Statistic for all covariates in Imbalanced and Matched Datasets

	Imbalanced	Matched
Female	11%	0%
Under Represented Minority	0%	0%
Asian	10%	0%
First Generation	4%	0%
Took any AP STEM	22%	0%
SAT Math	0%	0%
SAT Writing	0%	0%
Adjusted Gross Income	0%	0%
Magnet High School	1%	0%
Public High School	2%	0%
Rural High School	2%	0%
Urban High School	1%	0%
First Semester GPA	1%	0%
Academic Year of Enrollment	10%	0%

Using linear probability models to compare outcomes between the URE participants and their matched counterparts, we observe positive impacts of the URE program on each of the outcomes considered:

3rd Semester Retention — Students who participated in the Early URE are a statistically-significant 3 percentage points more likely to return to a second year at the university ($p < 0.001$).

Degree Attainment — Students who participated in the Early URE are not statistically more likely to graduate with a bachelor degree. However, early URE students are 6 percentage points more likely to graduate with a bachelor’s degree within a four-year time frame ($p = 0.04$).

STEM Degree Attainment — Early URE students are 13 percentages more likely to graduate with a STEM degree than their matched counterparts ($p < 0.001$).

As noted above, we regard these results are encouraging but preliminary. The next step in our analysis will be using a difference-in-differences approach to fine-tune these estimated impacts once we have complete data on program applicants as well as participants. We will also examine variation in impacts according to key characteristics such as gender, race / ethnicity, first-generation status, and prior academic preparation.

References

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