Community College Students Assessed as Needing Mathematics Remediation: Seven-Year Impacts of Corequisite Remediation with Statistics[1]

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Corequisite remediation, which places students directly into college-level work with additional academic support, has emerged as a robust alternative to stand-alone, prerequisite, developmental education. In 2013, we conducted the first published experimental evaluation of corequisite remediation. Our seven-year outcomes data indicate that the benefits of corequisite remediation with college-level statistics include substantially higher rates of associate's and bachelor's degree completion, as well as greater earnings.

Introduction

Stand-alone, prerequisite, developmental (also known as remedial) education presents a serious obstacle to community college student success. Each year, approximately two-thirds of entering community college students are assigned to take one or more noncredit developmental courses. Mathematics is the most common remedial course assignment, with nearly 60 percent of new students required to take such courses (Chen & Simone, 2016). Developmental assignment has substantial negative consequences, because community college students assigned to these courses are far less likely to complete their studies than those who begin in credit-bearing courses (Scott-Clayton & Rodriguez, 2012).

Corequisite developmental education places students assessed as needing developmental courses directly into college-level courses with concurrent academic support – such as by means

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of peer tutoring or a concurrent "lab" section. Studies have shown that corequisite students are more likely to complete their gateway requirements quickly and at lower cost (Belfield et al., 2016; Vandal 2014). Some states and college systems have taken the lead in implementing corequisite reforms (e.g., California Community Colleges, 2018; Colorado General Assembly, 2019). Practitioners have also begun to identify best practices to facilitate colleges' adoption of corequisite courses (e.g., Richardson, 2021). However, nationally, implementation of policy reforms has been slow. A national survey of colleges revealed that most were still using sequences of noncredit developmental courses, particularly in mathematics (Rutschow & Mayer, 2018).

In fall 2013, we conducted one of the first rigorous studies of corequisite mathematics education for students assessed as needing developmental algebra. That randomized controlled trial (RCT) has shown that students assigned to corequisite remediation with statistics were more likely: to pass those courses than traditional remedial algebra courses; to earn college credits in their first year; to pass advanced mathematics courses, and to complete associate's degrees within three years (Logue et al., 2016, 2019). We now report seven-year student data, which allow us to assess the long-term impacts of corequisite mathematics remediation with statistics, including on bachelor's degree completion and earnings.

The Intervention

During the summer of 2013, at three participating City University of New York (CUNY) community colleges, we randomly assigned 907 students assessed as needing remedial elementary algebra to one of three fall 2013 course types: (a) traditional, remedial, noncredit, elementary algebra (Group EA, the control group); (b) that course with weekly workshops (Group EA-WS); or (c) college-level, credit-bearing statistics with weekly workshops (Group

Stat-WS, the corequisite [treatment] group).[2] Each instructor who participated in the experiment taught one section of each course type, and all instructors were asked to grade their courses as they would traditional remedial and statistics courses. Advanced undergraduates or recent community college graduates led the once-weekly workshop sections. One of the lead researchers recruited, trained and supervised the workshop leaders.[3]

The results from one year following the intervention (Logue et al., 2016) showed that students assigned to corequisite statistics were significantly more likely to pass that course (55.7 percent) than were students assigned to stand-alone elementary algebra (36.8 percent). We also showed that Stat-WS students completed an average of 3.1 additional college-level credits in their first year, beyond those earned in the statistics course. The three-year follow-up analyses showed that Stat-WS students were as or more successful in passing all types of college courses, including passing a significantly greater number of advanced mathematics courses, and they also completed associate's degrees at substantially higher rates than EA students (Logue et al., 2019).

Data & Measures

The seven-year follow-up data for our study were provided by CUNY's Office of Applied Research, Evaluation, and Data Analytics (OAREDA), supplemented by records OAREDA obtained from the National Student Clearinghouse.[4]

In the analysis presented here, we have used an intent-to-treat (ITT) approach to assess student outcomes, meaning that we have assessed all assigned students as part of the group to which they were assigned, regardless of what happened following initial assignment. The results presented here focus on differences between EA (traditional remediation, the control group) and

[2] In the limited space of this brief, we do not examine outcomes for the EA-WS group.
[3] Full details of the research design are contained in our first report (Logue et al., 2016).
[4] We are thankful to CUNY's OAREDA, particularly Z. Tang and S. Sheets, for providing us with data since the experiment was first conducted.

Stat-WS (corequisite remediation with statistics, the treatment group) on the following three outcomes: the proportion that completed an associate's degree, the proportion that completed a bachelor's degree, and mean wages. Given that our RCT resulted in well-balanced treatment and control groups, we used simple t-tests to evaluate statistical significance.

Degree completion records included calendar dates, which we aggregated into Winter/Spring and Summer/Fall for each year in Figure 1 below. The dashed lines on the figure represent the proportion of the group that earned a credential (left-side y-axis) by a particular term (bottom x-axis). Dotted lines represent associate's degrees, and dashed lines represent bachelor's degrees. For wages, the points constituting the solid lines represent the mean earnings for each group (right-side y-axis) by calendar year (top x-axis). For each pair of lines, blue represents the corequisite group (Stat-WS) and orange represents the traditional remediation group (EA).

Findings

In Figure 1, for associate's-degree completion, differences between the Stat-WS and EA groups began to emerge two years after the experiment, and became statistically significant after three years. At that point, Stat-WS students had a 41 percent higher associate's degree completion rate (25.6 percent) than EA students (18.2 percent).[5] The difference in the associate's degree completion rate narrows thereafter, to about five percentage points, but does not disappear entirely. As expected, bachelor's degree completion begins about four years after the intervention, and group differences emerged shortly thereafter. By fall 2018, five years after the intervention, 13.5 percent of Stat-WS students had completed a bachelor's degree, compared with 6.7 percent for EA-WS students ($p<.01$). Stated simply, the intervention doubled five-year

[5] The effect on associate's-degree completion is slightly different than that reported in our earlier publication, owing to additional degree completion data becoming available.

bachelor's degree completion. As with associate's degree completion, the rate difference narrows thereafter to about 3 percentage points, but does not disappear. In general, assignment to corequisite mathematics appears to lead to more timely degree completion.

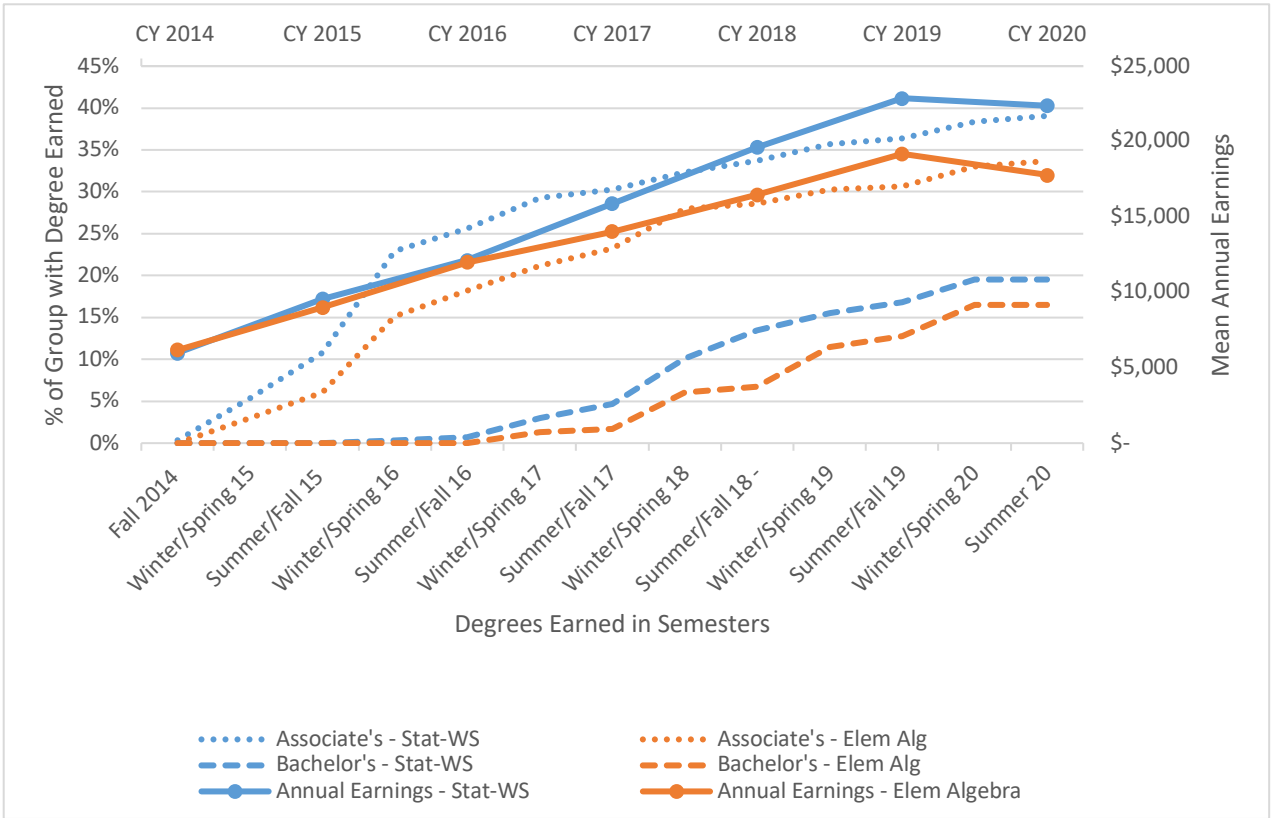

Figure 1. Degrees completed by term, and wages earned by calendar year, for Elementary Algebra (EA) and Statistics with Workshop (Stat-WS) students (297 students per group).[6]

The data for annual wages show a similar and related pattern. Up through 2016 (three years after the fall 2013 intervention), the two groups' mean earnings are approximately equal. But beginning in 2017, one year after we observed a significant difference in associate's degree completion, we see a mean wage difference begin to emerge in favor of Stat-WS students. In 2018 we observe a statistically significant annual earnings differences of about $3,200. This

[6] Underlying statistics for Figure 1 are included as Appendix A.

difference grows to $3,700 in 2019, and to $4,500 in 2020. The observed difference in 2020 is notable given that average earnings for both groups declined, but the losses were greater among the control group (though not statistically significantly so). In a separate analysis (not presented here) we found that the wage effect was not mediated simply by whether students earned degrees.[7] This finding is consistent with the fact that both groups eventually earned degrees at similar rates. In contrast, time to degree was found to be a mediator, suggesting that students in the Stat-WS group ultimately earned more when the intervention helped them complete their degree programs sooner. Finally, as was also the case with our one-year and three-year analyses, we found no significant differences in the effect of the intervention based on students' race or gender.

Implications

We conducted our experiment before states and community colleges began to widely implement the corequisite model of developmental education and, to date, our experiment is the only peer-reviewed RCT evaluating this approach.[8] Following our participants for seven years provides a unique view of the long-term impacts of corequisite remediation with statistics. The results are uniformly positive, and demonstrate returns far beyond the completion of a single required course. Students assigned to corequisite statistics instead of stand-alone developmental algebra were, on average, more likely to complete timely associate's and bachelor's degrees, and eventually saw an earnings advantage of about $4,600 per year.

[7] Mediation analysis is used in experimental studies to help understand how an intervention produces its effect (VanderWeele, 2016).

[8] The work reported in our original 2016 publication was reviewed by the Institute of Education Sciences What Works Clearinghouse, which gave this work the highest possible group design rating of meeting standards "without reservations" (What Works Clearinghouse, 2018). IES has since classified this work as an Every Student Succeeds Act (ESSA) Tier 1 Intervention, owing to the strong design and the observed impacts.

The data from calendar year 2020 showed a decline in wages for both groups, but the decline was larger for those assigned to traditional remediation. This finding is consistent with recent data showing that people with college degrees have fared better against the economic impacts of COVID-19 (Carnevale & Gulish, 2020; Mahnken, 2020).

Given that these benefits accrue to students regardless of race, and that students from underrepresented groups are more likely to be assigned to remediation (Chen & Simone, 2016), widespread implementation of corequisite statistics would help to close race-based degree completion gaps. These findings should be considered by policymakers and educators considering corequisite remediation, as well as by those in the midst of such reforms.

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Appendix A. Means, Standard Errors, and 95% confidence intervals for Figure 1.

	Elementary Algebra (EA)				Corequisite Statistics (Stat-WS)			
	Mean	SE	Lower Bound	Upper bound	Mean	SE	Lower Bound	Upper bound
Proportion of group with associate's degree								
Fall 2014	0	0	0	0	.003	.003	-.003	.01
Winter/Spring 2015	.03	.01	.01	.05	.05	.01	.03	.08
Summer/Fall 2015*	.06	.01	.03	.09	.11	.02	.07	.14
Winter/Spring 2016*	.15	.02	.11	.19	.23	.02	.18	.28
Summer/Fall 2016*	.18	.02	.14	.23	.26	.03	.21	.31
Winter/Spring 2017*	.21	.03	.17	.26	.29	.03	.24	.34
Summer/Fall 2017*	.23	.02	.18	.28	.30	.03	.25	.36
Winter/Spring 2018	.28	.03	.23	.33	.32	.03	.27	.38
Summer/Fall 2018	.29	.03	.23	.34	.34	.03	.28	.39
Winter/Spring 2019	.30	.03	.25	.36	.36	.03	.30	.41
Summer/Fall 2019	.31	.03	.25	.36	.36	.03	.31	.42
Winter/Spring 2020	.33	.03	.28	.38	.38	.03	.33	.44
Summer 2020	.34	.03	.28	.39	.39	.03	.33	.45
Proportion of group with bachelor's degree								
Fall 2014	0	0	0	0	0	0	0	0
Winter/Spring 2015	0	0	0	0	0	0	0	0
Summer/Fall 2015	0	0	0	0	0	0	0	0
Winter/Spring 2016	0	0	0	0	.003	.003	-.003	.01
Summer/Fall 2016	0	0	0	0	.007	.005	-.002	.02
Winter/Spring 2017	.01	.01	0	.03	.03	.01	.01	.05
Summer/Fall 2017*	.02	.01	.002	.03	.05	.01	.02	.07
Winter/Spring 2018	.06	.01	.03	.09	.10	.02	.07	.14
Summer/Fall 2018**	.07	.01	.04	.10	.13	.02	.10	.17
Winter/Spring 2019	.11	.02	.08	.15	.15	.02	.11	.20
Summer/Fall 2019	.13	.02	.09	.17	.17	.02	.13	.21
Winter/Spring 2020	.16	.02	.12	.21	.20	.02	.15	.24
Summer 2020	.16	.02	.12	.21	.20	.02	.15	.24
Annual earnings ($)								
CY 2014	6,169	553	5,081	7,257	5,989	508	4989	6990
CY 2015	9,001	680	7,661	10,340	9,569	669	8,253	10,886
CY 2016	11,993	814	10,391	13,595	12,140	775	10,615	13,666
CY 2017	14,027	912	12,233	15,822	15,882	938	14,037	17,729
CY 2018*	16,458	997	14,496	18,420	19,631	1,114	17,439	21,824
CY 2019*	19,182	1,105	17,009	21,357	22,876	1,258	20,400	25,351
CY 2020**	17,780	1,185	15,449	20,112	22,386	1,325	19,779	24,993

*p<.05 **p<.01