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Does Online Course-Taking Increase High School Completion and Open Pathways to Postsecondary Education Opportunities?

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Recent increases in high school graduation rates have been linked anecdotally to online course-taking for credit recovery. Online course-taking that supports high school completion could open opportunities for postsecondary education pursuits. Alternatively, poorer quality online instruction could diminish student learning and discourage persistence toward graduation and further education. Using quasi-experimental methods in an 8-year longitudinal study of high school online course-taking, we find positive associations between online course-taking, credits earned and high school graduation, and for those with limited online course-taking, small increases in college enrollment. However, we find significantly lower 4-year college enrollments and lower quality college enrollments for all online course-takers, leaving open the question of whether online course-taking will lead to long-term postsecondary education and labor market success.

Keywords: *technology, achievement, equity, high schools, postsecondary education, mixed methods, longitudinal studies, quasi-experimental analysis*

Introduction

For more than a decade, compelled by the federal mandate under No Child Left Behind (NCLB) to report graduation rates, states have sought to identify policy levers for increasing high school graduation rates. The Every Student Succeeds Act (ESSA), passed in December 2015 to replace NCLB in governing K–12 public education policy in the United States, continues this focus on high school graduation rates as a core academic performance indicator of federal and state public school accountability systems. The ESSA accountability system is also evolving, however, in that it provides states with greater flexibility to create a more "holistic" evaluation of school quality and student success. In addition to graduation rates and student achievement (standardized test scores), ESSA requires at least one other performance measure that is valid and reliable statewide, including, for example, measures of student engagement, access to advanced coursework, postsecondary readiness, or others that gauge students' ability to think critically and work collaboratively (Darling-Hammond et al., 2016).

Nationally, the most recently available graduation rate statistics (updated in January 2019) reported an adjusted cohort graduation rate (ACGR) for public high school students of 84.6% (for the 2016–2017 school year), the highest rate since it was first measured in 2010–2011 (at 79%; Valentine, 2018). Concerns have been raised, however, about whether these trends reflect real advances in student learning and academic success, given that high school student performance on the National Assessment of Educational Progress (NAEP)[1] and Programme for International Students Assessment (PISA) has stagnated over this same period. In some states, the rise in high school graduation rates has been particularly dramatic (PISA, 2016). In Alabama, for example, the on-time graduation rate rose from 72% in 2010–2011 to 86% in only 3 years (2013–2014), and Florida reached another high in 2018, also with a graduation rate of 86%, representing an increase of more than 23 percentage points in a decade (from 62.7%), according to the state's department of education (Postal, 2018). Importantly, the latest increases in on-time graduation rates in Florida also narrowed the gaps between the performance of White students and Black and Hispanic students, as well as for students from low-income families.

Some have linked the recent substantial increases in high school graduation rates to the proliferation of "credit recovery" programs, in which students repeat failed courses in an alternative (e.g., online) and sometimes abbreviated format (M. Dynarski, 2018; Malkus, 2018). For example, the Gadsden County School District in Florida, which had a 43% graduation rate in 2010, was searching for a way to quickly boost its graduation rate. It turned to an online credit recovery program (EdOptions) to help students who had failed in-person classes to graduate on time because "it was getting results" in other districts across the state (Kirsch, 2017). As Gadsen County increased its reliance on online credit recovery, its graduation rate rose to 68.4% in 2016. Other large metropolitan school districts, such as Nashville, Los Angeles, and the District of Columbia, have likewise seen dramatic increases in their high school graduate rates (of more than 15–20 percentage points) after introducing online credit recovery programs (Kirsch, 2017; Malkus, 2018). Again, however, the lack of comparable, broad-based increases in high school test scores where these programs have rapidly expanded has prompted the question of whether they are adding value to students' learning (The Economist, 2019). This is a serious concern, given that approximately three-fourths of U.S. high schools are now offering digital instruction opportunities to help students who have failed a course regain credit, stay on track for graduation, and complete their high school degree (Powell, Roberts, & Patrick, 2015).

In this article, we analyze online course-taking that is used primarily for credit recovery, but we also perform our analyses on a subsample of students who previously failed a course, allowing us to focus specifically on credit recovery facilitated through an online course system. We also acknowledge that some of the arguments for and against these courses could be relevant to face-to-face and school district–developed credit recovery courses, as well as to other forms of online instruction.

On the one hand, given that a high school degree is generally required to enroll in postsecondary education programs, online credit recovery courses that enable or support high school degree completion could open opportunities that might not otherwise be available for student postsecondary education pursuits. Of the 3 million high school completers in 2015, 69% enrolled in college by the following October, which represents an increase in the immediate college enrollment rate of 6 percentage points since 2000 (National Center for Education Statistics [NCES])[2]. In addition, online course-taking typically offers options for flexible, "anytime, anywhere" access to instruction that may allow students who are struggling in traditional classrooms to make progress toward graduation in other settings. Belfield and Levin (2007) estimated the value of lifetime economic (gross) benefits to the public associated with an additional high school graduate to be about US$209,000 in 2004 dollars (or US$283,676 in 2020 dollars). The online setting may also provide additional opportunities for individual counseling and goal-setting that could influence educational engagement and aspirations or help to accommodate the needs of students with disabilities (Darling-Aduana et al., 2019).

On the other hand, the fact that students are often assigned to online credit recovery courses after failing a course in a traditional classroom or being removed for behavioral problems raises concerns about ability grouping, which has been associated with unequal access to quality learning opportunities and increases in achievement gaps between high- and low-achieving students (Brighouse et al., 2018). And if online instruction substitutes poorer quality digital instruction for better quality live instruction, student engagement and learning could diminish, and students could be discouraged from persisting toward graduation or pursuing further education beyond high school. Delivering poorer quality digital instruction also abdicates the moral imperative of education to support students' intellectual development and raises important equity considerations, given that the students assigned to these courses are frequently from predominately marginalized groups.

We have undertaken a longitudinal study of the implementation of an online instructional program in a large, urban school district in the Midwest, which began offering online course-taking opportunities in 2010 primarily, but not exclusively, for high school students falling behind in their academic progress toward graduation (i.e., credit recovery). Nearly every high school in the district has enrolled students in online courses in at least 1 year over our study period. Furthermore, by the 2016–2017 school year, about 20% of all credits accrued in the district's middle and high schools were completed online, and 40% of graduating seniors had completed at least one course through the online course-taking system. The large-scale data set that we have assembled in this study links technology vendor data to student school records—from 2010–2011 to 2017–2018—and provides information on students' online (and traditional) course-taking that allows us to construct detailed, student-level measures of the intensity, duration, and types of online course-taking over time. We have also linked National Student Clearinghouse (NSC), College Scorecard, and U.S. News and World Report (USNWR) data that provide information on student participation in postsecondary education and the quality of institution attended. In addition, since 2015, we have conducted more than 300 observations of student and classroom use of the online instructional program and more than 30 interviews with instructors and district staff (Heinrich et al., 2019). The qualitative research was critical to informing our understanding of how (and when) schools directed students to take courses online and what online instruction looked like across and within schools and classrooms in the district.

We use these data to address the following key questions. Are there strong associations between online course-taking (primarily for credit recovery) in high school (and the intensity of online course-taking) and high school graduation and college enrollment? For students enrolling in postsecondary education, do we see differences in where students enroll (e.g., 2-year vs. 4-year colleges and institutional quality) that relate to whether they took courses online in high school and their intensity of online course-taking? We employ school-by-cohort fixed-effects models in our primary analysis and inverse probability weighting with regression adjustment (IPWRA) in analyzing the relationship of intensity of online course-taking to high school graduation and college enrollment outcomes. In addition, we undertake a secondary analysis to explore how online course-taking might contribute to learning and progress toward high school graduation (test scores, course credits earned, and grade point average [GPA]) using IPWRA models.

Overall, we find consistent positive associations between online course-taking in high school and high school graduation. For those students with very limited online course-taking, we observe small increases in college enrollment as well. However, we also find significantly lower 4-year college enrollment and lower quality postsecondary institutional enrollments for all online course-takers. Despite the positive associations with high school completion, our results leave room for questioning whether online course-taking contributes to student learning that will lead to long-term postsecondary education and post–high school success.

Theoretical Perspectives Informing the Proliferation of High School Online Course-Taking and Evidence on its Effectiveness

In framing this research, we draw on theoretical perspectives grounded in "new institutionalism" in education (Meyer & Rowan, 2006) to understand school district motivations for adopting and implementing online course-taking in high schools. Scholars bringing this theory to their investigations of educational organization and practice call attention to important changes in the political and social environments of public schools that have spurred demands for increased accountability for student outcomes while reducing confidence in the public sector to deliver on them. NCLB, for example, followed on the broader new public management (NPM) reforms of the 1990s that encouraged the devolution of government responsibilities to the private sector (Hood, 1991) to promote flexibility, choice, and accountability for results (Public Law 107–110—8 January 2002). Rowan (2006, p. 16) describes how this has prompted a "heightened concern with educational productivity" and the embracing of an increasingly "technical theory" of education that affords a growing role for private actors and "big business." He points to the private sector's expansion into home schooling, charter schools, and supplemental educational services that are becoming an institutionalized part of public education.

We likewise argue that there is a new level of penetration by private actors into the "technical core" of public education, extending beyond the more limited roles of supplying standardized textbooks or tests to the provision of curricular content and the delivery of core course instruction in public schools. New institutionalism suggests that institutional reform of the technical core of public education is typically motivated by the identification of a performance problem (Rowan, 2006), such as the concern around low high school graduation rates that motivated annual reporting of graduation rates by states under NCLB. These early accountability efforts illuminated not only national graduation rates of 68% (of those entering ninth grade and graduating with a regular diploma in 2001) but also major disparities in the high school graduation rates of minorities (Blacks—50%, American Indians—51%, and Hispanics—53%) and a lack of consistency and accuracy in the calculations (Orfield et al., 2004). The report by Orfield et al. (2004) declared an educational crisis, in which the U.S. education system was allowing a "dangerously high percentage of students to disappear from the educational pipeline before graduating from high school" (p. 2). Moreover, their report described students who felt "pushed out" of high school because of their poor performance on standardized tests or severe problems they were experiencing outside of school that made it difficult for them to progress toward graduation, with these glaring inequalities contributing to a national *civil rights* crisis.

Described as a "byproduct" of the NCLB reforms, credit recovery programs began proliferating after the passage of NCLB, with the basic objective to provide students who were falling behind academically the opportunity to "recover" credits through primarily online options (McCabe & St Andrie, 2012). Through the lens of new institutionalism, credit recovery is essentially a technical fix for the problem of high school students lagging in their accumulation of credits needed for graduation. While there is no federal or uniform state definition of what constitutes credit recovery and minimal oversight of the burgeoning programs, McCabe and St. Andrie (2012) identified one of the clearer definitions of credit recovery in the North Carolina State Board of Education's Policy Manual, which characterizes credit recovery as "a block of instruction that is less than the entirety of the Standard Course of Study for that course," with the length of the credit recovery course not fixed by "seat time" but rather "dictated by the skills and knowledge the student needs to recover."[3]

Public monies have been made available for the expansion of credit recovery via Title I funding, the Individuals with Disabilities Education Act (IDEA), Enhancing Education Through Technology (EETT), and other federal funding (e.g., American Reinvestment and Recovery Act). These funds have largely been diverted to contracts with private educational companies such as Apex Learning, Edgenuity, and Pearson Education that are supplying the surging demand for online credit recovery programs, particularly in large, urban school districts such as Los Angeles (LA) Unified, Chicago Public Schools, Houston Independent School District, Miami-Dade, and others (Clough, 2016a). With ensuing record increases in high school graduation rates—for instance, LA Unified's reported achievement of a 75% graduation rate in the 2015–2016 school year after a 54% rate was projected in fall 2015 (Hanson, 2017)—growing concerns about the quality of education provided through these online courses and the absence of monitoring and regulation have been raised (Ahn & McEachin, 2017; Heinrich et al., 2019; Heppen et al., 2017). The International Association for K-12 Online Learning (Powell et al., 2015, p. 10) was particularly blunt in its criticism of online credit recovery programs, noting that they are

> low-cost, have very low levels (if any) of teacher involvement, and require very little of students in demonstrating proficiency. They are used primarily because they are inexpensive, and they allow schools to say students have "passed" whether they have learned anything or not.

Still, while acknowledging some unease about the fast pace of credit recovery and accelerating graduation rates, state and local educational agency leaders are mostly defending their use. Former Texas Education Commissioner, Robert Scott, remarked that "any tool that helps get kids credit toward graduation is certainly worth having" (Thevenot & Butrymowicz, 2010), and LA Unified Chief Academic Officer, Frances Gipson, argued that "whether it's online or any other credit recovery course, it's the same" (Clough, 2016b).

Gipson highlights a key question: Is a credit a credit, no matter how it is attained, or should we be concerned about whether directing students to credit recovery reduces their quality of learning opportunities and later outcomes (i.e., beyond graduation)? The most rigorous evidence to date from an experimental study of online course-taking for recovery of algebra credits (vs. a face-to-face option) in Chicago Public Schools found that students in the online course had significantly lower end-of-course posttest scores and lower credit recovery rates compared with those in the face-to-face course (Heppen et al., 2017). Similarly, in a comparative interrupted time-series of North Carolina credit recovery programs, Viano (2018) found that online credit recovery course offerings were associated with a decline in student test scores and graduation rates. In more recent work, Viano and Henry (2020) examined whether students taking courses for credit recovery were more likely to graduate and less likely to drop out than those taking traditional courses and found a lower likelihood of dropping out of high school associated with credit recovery, but also less learning as measured by end of course exams and ACT scores.

If the alternative to credit recovery programs is pushing students out of high school, as Orfield et al. (2004) suggested, and large, resource-constrained urban school districts are unable to bolster blended learning and instructional supports, reduce class sizes, and undertake other measures to improve student progress toward graduation, then credit recovery programs that "fix" the performance problem—move students to graduation and reduce disparities in graduation rates—may be seen as the most cost-effective option available to these school districts. We estimate the costs of operating online credit recovery based on information provided by our study district and compare those estimates with Levin and Belfield's (2007) estimated unit (present value) cost of educational interventions found to increase high school graduation rates, including early childhood education, class size reductions, and teacher salary increases. Our cost estimates, described in greater detail in the findings section, suggest that credit recovery may be considerably less expensive than other interventions shown to increase graduation rates.

As Burch (2009) argued, however, the new institutionalism underlying many recent policy reforms—including those contributing to the rise of online credit recovery—is an inadequate lens for attending to questions about equity and social justice, such as how the problem of low and disparate high school graduation rates is rooted in deeper societal and economic inequalities. She cautions against settling for "simplistic" solutions offered by the market to complex challenges in which "too many children in communities of color are lost" in our public education system (2009, p. 19). Levin (2009) likewise counsels that "fairness in access to good education is a matter of justice rather than simple economic rationality as measured by investment returns" (p. 5). In other words, when elevating principles of equity and justice in educational programming decisions, it becomes harder to see regaining credits required for high school graduation as a success if little is done to support students' intellectual development or prepare them well for postsecondary pursuits. Indeed, to the extent that rising graduation rates divert attention from underlying structural inequities and allow marginalized groups to continue to be underserved by educational institutions, then credit recovery programs may potentially do as much harm as good for these students. In this study, we investigate this latter concern, that is, whether as implemented in a large urban school district, online credit recovery might negatively affect students' post–high school educational opportunities, even if it increases the chances they complete high school.

Program Implementation and Selection Into Online Credit Recovery

The school district in this study contracted with a single third-party vendor to develop and deliver the course content in the online courses for all subject areas (English and language arts, math, science, social studies, and elective courses). This particular technology vendor provides online courses to school districts in all 50 states, including eight of the 10 largest districts in the nation, which use the program primarily for credit recovery (Clough, 2016b). The vendor provided training at the start of the school year to teachers in classrooms or lab-style settings where the online instruction was made available to students, including technical training on how to use the course-taking system and troubleshoot problems (e.g., student difficulties logging into the system). School district staff provided additional training, support, and guidance to teachers in regular professional development (PD) sessions and communications during the school year, including information on practices for improving instructional delivery, such as encouraging student note-taking during online instructional videos, conducting weekly check-ins of student progress, and regularly monitoring student online course progress during class periods (Heinrich et al., 2019). Although the course content was developed by the vendor's team of curriculum developers and adapted as needed to meet state standards and district requirements, there was also a mechanism in place for lab instructors to flag content as incorrect or offensive, after which the vendor adjusted content accordingly.

Approximately one-quarter of high school students in the study district accessed course instruction online in a given year, having steadily risen from about 5% of all high school students in the first year (2010–2011) the online instructional program was used. The district also provided credit recovery course options in traditional classroom settings, with about half of all students who failed a course re-taking the courses in traditional classrooms and the other half enrolling online each year. In an interview with the credit recovery program coordinator, we inquired as to whether students were able to choose between credit recovery online and repeating a course in a traditional classroom, and also whether students could refuse the online option if they were assigned to it. The program coordinator explained that both schools and students generally preferred the online option for credit recovery; in other words, if credit recovery was an option in their schools and students were assigned to repeat a course online, they mostly complied. The credit recovery program coordinator also indicated that it was more costly for schools to place students in traditional classrooms to repeat a course, and "very few students" preferred the traditional classroom route because it was a semester-long course. Alternatively, in the online credit recovery option, students could test out of course modules and work at a faster pace to complete courses sooner. Students could also work on their online courses outside the regular school day, and our analysis showed that over 15% of time logged in the online course system was outside school hours.

Accordingly, whether a student recovered failed course credits in a traditional classroom or online depended primarily on access to the online instructional program in their school. Across the district, we found that the proportion of high school students taking online courses in any one of the 46 high schools (during our study period) ranged appreciably between and within high schools over time (e.g., from zero to more than 93%). Our interviews with district staff and teachers suggested that school-level administrative and staffing decisions, in conjunction with the types of student bodies served, were among the most important factors in determining which and how many students were directed to take courses online (Heinrich et al., 2019). For example, in one school, a new school principal wanted to understand more about the online course-taking program before committing instructional space for its use, and hence in her first year, only students who had not completed their online courses in the prior year were allowed to continue with the program (contributing to a steep decline in the rate of student online course-taking that year). In alternative high schools, about a third of the student body took courses online, although the rate of online course-takers was more than 80% to 90% in some schools, such as a school serving students returning to the classroom from the juvenile justice system or expulsion. In addition, over time, the school district reduced online course-taking by students in the ninth and 10th grades because of their lower reading levels and lack of sufficient self-regulation for independent learning.

The fact that we empirically observed substantial year-to-year variation in the percentage of students taking courses online—even when student characteristics such as the proportion failing their courses (one of the strongest individual predictors of online course-taking), eligible for free or reduced-price lunch, and scoring low on standardized tests was varying negligibly over time—also suggests that administrative decisions (rather than student selection) were the primary drivers of the setting (online vs. traditional) in which failed credits were recovered. As an illustration, one school with substantial year-to-year fluctuations in the proportion of its students taking courses online saw an increase of more than 50%, followed by a decline of 16%, then another increase of nearly 30%, another decline of 12%, and so on, even as student characteristics were stable. Moreover, our analyses predicting online course-taking (discussed further below) showed that school-level characteristics—including school-level demographics, course offerings (advanced, career and technical, service learning), and school type (alternative, charter, etc.)—accounted for more than two-thirds of the explained variation in the intensity of online course-taking (vs. less than one-third of explained variation accounted for by individual student attributes, including course failures). We leverage this school-level variation in the proportion of students taking courses online and control for key student-level characteristics in our empirical analyses, discussed below. However, we acknowledge that there may be unobserved selection bias at school and student levels that we do not adjust for; hence, we present our findings as descriptive rather than causal.

Study Samples, Data, and Measures

We link the student record data provided by the district for high school students from the 2010–2011 through 2017–2018 school years to data from the vendor of the online instructional program for this same period, matching about 85% of the cases on average.[4] The vendor data include detailed information on students' online courses and their engagement with the online instructional system (for each session, a student logged in) and measures of their course progress, completion, and online course grades. Using these data, we were able construct measures of students' intensity of online course-taking over time as well. The student record data include demographic information, absences, suspensions, course credits earned, GPA, ACT scores and standardized test scores. We also merged data on school characteristics, including school type, geographic location, and others that are made publicly available on the district website.

Treatment and Outcome Measures

In defining student participation in online course-taking, we use an indicator variable to denote whether a student enrolled in at least one online course in high school, and we also examine the intensity of online course-taking among students enrolling in online courses. Over our study period, high school students in this district who engaged in online course-taking enrolled in an average of two online courses in a year. The 90th percentile of the distribution was five courses, and there was a long right-hand tail extending to 35 courses in a single year (including summer school). Students taking more courses online were failing more of their courses (and falling further behind academically), and our qualitative research suggested that students repeating large numbers of their courses online were also more likely to be distinct in other ways, such as pregnant or parenting teens and those with higher rates of absences or expulsions.

To better understand how online credit recovery affects the outcomes of these different student subgroups, we developed a measure of online course-taking intensity that factored in both the number of online courses taken and the number of years in high school that students enrolled in online courses.[5] The categorical measure of online course-taking that we use in our analysis is defined as follows: (a) students who enrolled in one to two online courses in 1 to 2 high school years (60% of online course-takers), (b) students who enrolled in three or more online courses in 1 to 2 high school years (27% of online course-takers), and (c) students who enrolled in online courses in 3 or more years of high school

(13% of online course-takers). The other (reference) category in this measure is students who did not take any of their high school courses online. In both qualitative and quantitative analyses, we observed that students who take only one to two courses online are typically in their last 2 high school years, are performing relatively better academically, and are trying to recover a failed core course or otherwise fulfill requirements for graduation as expediently as possible. Students who enrolled in three or more online courses over 1 to 2 years were more likely to be struggling academically and taking courses online to get back on track for graduation. Finally, students enrolling in courses online for 3 or more years of high school were doing the least well academically (as measured by prior year test scores, GPAs) and were more likely to have special educational needs.

Although our analyses of progress toward graduation are secondary to our core focus on high school graduation and postsecondary educational pursuits, because test scores and GPA have been linked to later outcomes such as college attendance and earnings (Allensworth & Clark, 2020; Goldhaber & Özek, 2019), we also examine these relationships. Credits earned and GPA are measured at the end of the academic year, and we examine two measures of academic achievement, reading and math standardized test scores, which are scaled scores from spring Measures of Academic Progress (MAP) and STAR assessments (nationally normed standardized assessments).[6] It is also important to point out that although Goldhaber and Özek (2019) conclude there is an abundance of evidence suggesting a causal link between test scores and later life outcomes, the empirical evidence base is mixed, with some research suggesting that test scores account for little of the relationship between high school completion and later outcomes such as earnings (e.g., Murnane et al., 2000, 2001). Because successful completion of an online course for credit recovery typically replaces a failed credit with a better grade on a student's transcript, if the opportunity to repeat a course online increases the likelihood a student will pass the course, we may also observe a positive relationship between online credit recovery and credits earned and GPA. The relationship between online credit recovery and test scores, alternatively, may depend on the relative quality of learning and the skills imparted in online versus traditional classroom settings, which may also factor into students' post–high school outcomes.

For our primary analyses, we use a measure of high school graduation that is not limited to 4-year (on-time) graduation but captures graduation as reported in the district student records.[7] College enrollment (in 2-year and 4-year colleges) measures were obtained through our study district from the NSC data, which are currently the most comprehensive national student-level college enrollment data available.[8] In addition, we use publicly available data from the College Scorecard[9] and information provided by the USNWR to measure college quality. From the College Scorecard, we use measures of the type of degree awarded by the institution (predominant and highest degrees), level of research activity, first-year student retention rate, college completion rate, and whether the college has open admissions. Some of the same measures of college quality were available from USNWR but were more complete in the College Scorecard. Thus, we limit our use of the USNWR data to an indicator variable for whether a given postsecondary institution is included among the USNWR-ranked institutions (a measure of selectivity).[10]

Analysis Samples

In examining the relationship between online course-taking in high school and progress toward graduation, high school completion, college enrollment, and institutional quality, we construct two primary treatment-comparison samples for our analyses. One, we compare students who took at least one course online in high school (a little over 40% of our sample) with students who did not complete any courses online. Two, given that after school-level factors are accounted for the strongest *student-level* predictor of online course-taking in our study district was course failure (consistent with the credit recovery focus), we also estimate our models on a subsample consisting only of students who failed a course in the prior year, where about half of these go on to repeat the course online. For courses required for graduation, which describes the majority of cases in our sample, students who did not repeat the courses online repeated them in a face-to-face instructional environment. In addition, we estimate our primary models on a subsample that is further restricted to students who have data available from their eighth-grade year to use as the baseline year in the analysis. This is intended to address the potential concern that our estimates of the associations between treatment and outcomes may be inflated because of regression to the mean. While this may be the subsample that most effectively addresses the potential for bias in our estimates, the trade-off is a considerably smaller (and more selective) sample, given that not all high school students had eighth-grade records in this school district.

Table 1 presents descriptive statistics on the students in these three analysis samples, with the first two columns comparing the student-level characteristics of all high school students in this district with online course-takers, the second panel showing the characteristics of the subsample of those who failed a course (both online course-takers and those who did not attempt to recover a course online), and the third set of columns showing those with eighth-grade (baseline) student records. With sizable samples, we observe mostly small yet some statistically significant differences between students taking courses online and those not taking courses online in high school across many student characteristics shown in Table 1. Comparing all high school students, the largest differences are the (higher) percentages of Black, low-income, and special education–eligible students taking courses online; the lower proportions of English language learners (ELLs), Asian, and 10th-grade students taking courses online; and lower GPAs, more absences, and higher rates of course failure among those in online courses. When we restrict the sample to students who had failed a course in the prior year, most of the differences between the students taking courses online (vs. not) are considerably smaller, and many of the differences are no longer statistically significant as well. The subsample of students with eighth-grade (baseline) records is particularly distinctive, however, in their significantly higher proportions of males, Black students, students with special educational needs, substantially higher rates of absences, and very low GPAs, regardless of whether they were taking courses online. This is clearly a more selective sample of high school students in this district who are at greater risk of poor educational outcomes, and they were also more likely to be in the subgroup taking courses online in 3 or more years of high school.

As shown in Figure 1(A), the proportion of high school students in the district who failed a course in the prior academic year is high (nearly two-thirds in 2011–2012) but generally declining over time (to about 56% in the 2017–2018 school year). At the same time, 4-year cohort high school graduation rates[11] closely parallel the trend in course failure, albeit moving in the opposite direction, with a sharper rise in high school completion following the 2014–2015 school year. Over this same period, the percentage of high school students taking courses online in a given year was increasing—to 18% in 2011–2012 (from 5% the previous year) to approximately a quarter of high school students in 2012–2013—and then ranging between 25% and 30% through the 2017–2018 school year. Figure 1(B) and 1(C) shows that average credits earned in a school year and student GPAs among high school students in this district were likewise largely increasing over the study period. In effect, the trends we observe in student progress toward graduation—in credit accumulation, in particular—appear consistent with the anecdotal evidence suggesting that online course-taking (primarily for credit recovery) may be associated with the rise in high school graduation rates.

We now describe the various analyses we undertake to investigate associations between online course-taking and student high school and postsecondary education outcomes and to assess whether the expansion in online credit recovery may be contributing to rising high school completion and potentially influencing postsecondary education enrollments as well.

Method

To estimate our primary outcomes of interest, high school graduation and college enrollment, we employed a school-by-cohort fixed-effects model, as shown in the equation below. This approach accounts for variation in assignment to and the implementation of online courses between

TABLE 1

Descriptive Statistics of Analytic Samples

	All students (N = 82,151)		Students who failed course in prior year (N = 49,541)		Students with eighth-grade baseline data (N = 10,926)	
Student characteristics	Not online course-taker	Online course-taker	Not online course-taker	Online course-taker	Not online course-taker	Online course-taker
Female	0.505 (0.500)	0.455* (0.498)	0.443 (0.497)	0.435 (0.496)	0.383 (0.486)	0.396 (0.489)
Black	0.591 (0.492)	0.674* (0.469)	0.674 (0.469)	0.693* (0.461)	0.691 (0.462)	0.730* (0.444)
Asian	0.081 (0.273)	0.030* (0.171)	0.043 (0.202)	0.023* (0.149)	0.034 (0.182)	0.012* (0.108)
Hispanic	0.201 (0.401)	0.207 (0.405)	0.202 (0.401)	0.205 (0.404)	0.207 (0.405)	0.189* (0.392)
Other race	0.007 (0.081)	0.008* (0.092)	0.007 (0.086)	0.009 (0.094)	0.009 (0.094)	0.010 (0.098)
English language learner (ELL)	0.098 (0.297)	0.075* (0.263)	0.101 (0.301)	0.073* (0.261)	0.133 (0.340)	0.074* (0.263)
Free/Reduced-price lunch eligible (FRL)	0.760 (0.427)	0.821* (0.384)	0.840 (0.367)	0.832* (0.374)	0.884 (0.320)	0.879 (0.326)
Special education eligible (SPED)	0.205 (0.404)	0.235* (0.424)	0.263 (0.440)	0.253* (0.435)	0.362 (0.480)	0.334* (0.472)
10th grader	0.351 (0.477)	0.282* (0.450)	0.343 (0.475)	0.284* (0.451)	—	—
11th grader	0.307 (0.461)	0.333* (0.471)	0.272 (0.445)	0.320* (0.467)	—	—
12th grader	0.238 (0.426)	0.218* (0.413)	0.195 (0.396)	0.199 (0.400)	—	—
Failed one or more courses in baseline SY	0.524 (0.499)	0.836* (0.370)	1.000 (0.000)	1.000 (0.000)	0.963 (0.189)	0.980* (0.139)
Credits attempted in prior SY	6.998 (1.173)	6.978* (1.472)	7.061 (1.314)	7.048 (1.381)	6.469 (1.563)	6.619* (1.477)
GPA in prior SY	2.088 (1.039)	1.433* (0.858)	1.352 (0.741)	1.197* (0.676)	0.640 (0.636)	0.598* (0.534)
Percent absent	0.166 (0.198)	0.245* (0.214)	0.246 (0.229)	0.266* (0.218)	0.393 (0.282)	0.359* (0.246)
N	61,311	20,840	32,123	17,418	7,181	3,745

Note. GPA = grade point average; SY = school year.
*Difference in means (between online course-takers and students not taking courses online) is statistically significant at $p < .05$.

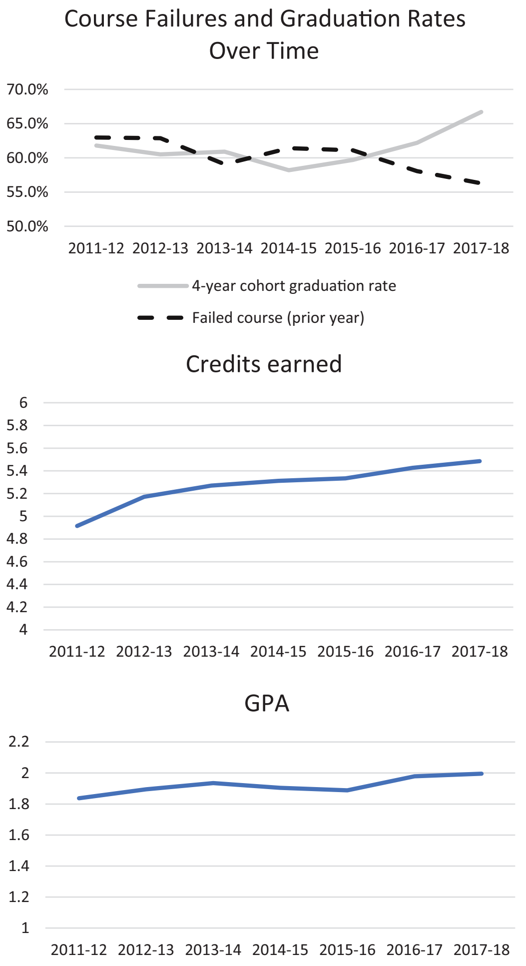

FIGURE 1. *Course failures and graduation rates, credits earned, and grade point average (GPA) over time.*

schools and within schools across different cohorts. In defining cohorts, school enrollment was identified as the first high school the student attended (observed in the study data), with student cohorts assigned based on when each student entered ninth grade. For students without ninth-grade data, we assigned the cohort based on the year and grade of the first year of data available for that student. When using lagged covariates, we used eighth-grade data (where available) as the baseline year. For students without eighth-grade data, we used the first year of high school data available as the baseline year. Our fixed-effects models would only identify *effects* of online course-taking if we could reasonably assume that no other unobserved, time-varying factors influenced online course-taking and student educational outcomes (the conditional independence assumption), which is not a claim we make in this analysis:

$$A_{jsc} = \alpha D_j + \beta_1 X_j + \beta_2 A_{j-1} + \beta_3 P_j + \delta_{sc} + \varepsilon_{jc}. \quad (1)$$

In the above model with the school-by-cohort fixed effects (δsc), A_{jsc} is the outcome of interest for student j attending school s in cohort c, D_j is an indicator for whether the student took courses online during high school, and X_j indicates each student's fixed demographic characteristics (such as race, ethnicity and gender), as well as whether the student ever qualified for free or reduced-priced lunch, ELL status, or special education services. A_{j-1} indicates the number of credits attempted, credits failed, GPA, and percent of days attended from the student's baseline year. P_j is a vector of school characteristics across a student's high school experience, including the maximum percentage of students in a school they attended that accessed online instruction and whether the student ever attended a school identified as an alternative school,[12] whereas ε_{jc} is the random error term.

As discussed above, student course failures, academic performance, and special educational needs are correlated with their intensity of online course-taking, making it also of interest to examine how the intensity of participation in online credit recovery relates to high school graduation and postsecondary education enrollments. Because we constructed a categorical treatment measure of online course-taking intensity—defined as zero online courses, one to two online courses in 1 to 2 high school years, three or more online courses in 1 to 2 high school years, or online course-taking in 3 to 4 years of high school—we use IPWRA, a doubly robust estimator that aims to align the observed characteristics of those with no online course-taking to the those of the three subgroups of online course-takers in their baseline years (as defined above). The IPWRA method uses probability weights from a model that predicts treatment status to obtain outcome-regression parameters that account for the fact that each student is observed in only one of the potential outcomes. The estimated inverse probability weights are used to fit weighted regression models of the outcome for each treatment level and to obtain predicted outcomes for each student, and then the average treatment effects (ATEs) are computed from these estimates of treatment effects.

The multi-valued treatment model used to estimate the effects of intensity of online course-taking, using the same covariates included in Equation 1, is specified as follows:

$$\widehat{ATE}_t = \frac{1/n\sum i=1^{n[D_{ti})/(\hat{p}_t(X_i)Y_i+\left(1-(D_{ti})/\left(\hat{p}_t(X_i)\right)\hat{\mu}_t(X_i)\right]}-1}{\left(n\sum i=1^{n[1-D_{ti})/(1-\hat{p}_t(X_i)Y_i+(1-\left(1-D_{ti})/\left(1-\hat{p}_t(X_i)\right)\hat{\mu}_0(X_i)\right]}\right)} = \hat{\Delta}(t)-\hat{\Delta}(0). \tag{2}$$

Regression adjustment models estimate separate regressions for each treatment level so that again D_{ti} is a binary variable that equals 1 if student i is in a given treatment *level* in year t and 0 if not. In the above equation, $\hat{p}_t(X_i)$ is the estimated propensity score for treatment level t and $\hat{\mu}_t(X_i)$ estimates $\mu_t(X_i) = E(Y[t]|X)$ for $t \in \{0, 1, \ldots, T\}$. The ATE is estimated in a three-step procedure, where the true propensity score $p_t(X_i)$ is estimated first, in this case with a multinomial logit model; the true regression model $\mu_t(X_i)$ is estimated next, and then they are combined as in Equation 2 to calculate the final result. The primary advantage of IPWRA is that the estimate for the ATE is consistent if the model either for the propensity score or for the potential outcome regression is correctly specified (the doubly robust property). As with the school-by-cohort fixed-effects models, we do not assert any causal effects because of selective differences in the intensity of online course-taking.

It was also of interest in this study to examine the associations between online course-taking and students' outcomes during high school—math and reading test scores, credits earned, and GPA—in part to understand the underlying mechanics of how credit recovery might accelerate a student's progress toward graduation (and open pathways to postsecondary education). We employed the doubly robust IPWRA approach in this analysis as well, adjusting for the same student characteristics (at the start of the school year in which instruction is accessed online), the lagged (prior year) value of the outcome, and time-varying school characteristics. The treatment in this model is defined as binary, where D_{ti} equals 1 for students who participated in online credit recovery in a given year and 0 for those who did not take courses online in year t, and the propensity scores are accordingly estimated by a logit model. In all IPWRA analyses, we specify robust standard errors clustered at the student level.

We estimated these models for our three primary samples: all students (full sample), students who failed a course, and students with eighth-grade baseline data. In addition, we also estimated these models with the sample constrained to include only 11th- and 12th-grade students who failed a course, given that the district disabled online credit recovery accounts of most ninth and 10th graders during the course of our study, because they were found to be less compatible and effective users of the online course-taking system (an insight confirmed in our prior empirical research, Heinrich et al., 2019). As these analyses are secondary to our primary focus on high school graduation and college enrollment in this study, the results are presented in the appendix. As a sensitivity test of our modeling choices, we also estimated the high school graduation and college outcomes using IPRWA (with the same controls and specification of standard errors as indicated above) for all students and students who failed a course in high school. The results of these analyses are also presented in the appendix.[13]

Research Findings

High School Graduation and College Enrollment

We hypothesized based on observed trends in high school progression through online course-taking and graduation rates in our study district, as well as existing anecdotal evidence on the relationship between online course-taking for credit recovery and high school graduation rates (Kirsch, 2017; Malkus, 2018), that we would see a positive association between online course-taking for credit recovery and graduation rates. Online course completion rates were steadily increasing over the period of our study, from less than 20% in the first two school years to more than 40% in the last several years.

Table 2 presents basic descriptive information on the primary outcomes we estimate—graduated high school, enrolled in college (2-year or

TABLE 2

Graduation and College Enrollment Descriptive Outcomes by Online Course Enrollment

Outcomes	Never enrolled online (*N* = 26,864)	Enrolled online: Enrolled online (*N* = 20,249)	Enrolled online: 1–2 courses in 1–2 years (*N* = 12,014)	Enrolled online: 3 or more courses in 1–2 years (*N* = 5,414)	Enrolled online: Enrolled in 3–4 years (*N* = 2,662)
Graduated high school	0.494 (0.500)	0.460* (0.498)	0.486 (0.500)	0.518 (0.500)	0.501 (0.500)
Enrolled in 2- or 4-year college	0.316 (0.465)	0.200* (0.400)	0.234 (0.424)	0.203 (0.402)	0.176 (0.381)
Enrolled in 4-year college/ university	0.160 (0.366)	0.075* (0.263)	0.097 (0.296)	0.073 (0.259)	0.054 (0.226)
U.S. news–rated institution	0.150 (0.357)	0.056* (0.229)	0.072 (0.259)	0.035 (0.183)	0.044 (0.206)
Open-admissions college	0.459 (0.498)	0.746* (0.435)	0.696 (0.460)	0.844 (0.363)	0.830 (0.376)
Highest degree: Associates	0.237 (0.425)	0.259* (0.438)	0.268 (0.443)	0.253 (0.435)	0.259 (0.438)
Highest degree: Graduate	0.476 (0.499)	0.160* (0.367)	0.217 (0.413)	0.095 (0.293)	0.091 (0.287)
Predominant degree: Associates	0.268 (0.443)	0.298* (0.457)	0.313 (0.464)	0.299 (0.458)	0.281 (0.450)
Very high research (R1)	0.145 (0.352)	0.033* (0.178)	0.049 (0.216)	0.011 (0.105)	0.012 (0.109)
First-year retention rate	0.664 (0.153)	0.576* (0.127)	0.592 (0.132)	0.546 (0.111)	0.549 (0.110)
Completion rate	0.363 (0.231)	0.242* (0.166)	0.260 (0.175)	0.215 (0.137)	0.203 (0.144)

Note. U.S. News and College Board data are not available for all students in the sample.
*Difference in means (between online course-takers and students not taking courses online) is statistically significant at < .05.

4-year), and enrolled in a 4-year college—as well as college quality indicators by online course-taking and the intensity of online course-taking. High school graduation and college enrollment rates are (statistically significantly) higher for high school students with no online course-taking versus any online course-taking—graduation rates are about 3 percentage points higher on average, and college enrollment rates (2-year and 4-year) are about 8 to 12 percentage points higher on average for those *not* taking courses online. Consistent with our discussion above that students with greater intensities of online course-taking are struggling more academically, the gaps in college enrollment rates increase with greater intensities of online course-taking. For students taking courses online in 3 or more years of high school, college enrollment rates are one-third to one-half of those with no online course-taking. In addition, all indicators of college quality suggest that students taking online courses and continuing on to postsecondary institutions are attending lower quality institutions. For example, students who enrolled in online courses are about 25 percentage points more likely to attend open-admissions colleges and 30 percentage points less likely to attend institutions that confer graduate degrees. First-year retention rates and college completion rates at these institutions are significantly lower (9 and 12 percentage points, respectively) as well.

In Table 3, we present findings on the relationship between high school online course-taking and high school graduation and college enrollment outcomes, showing the results from our main school-by-cohort fixed-effects regressions for (a) the full sample, (b) the sample restricted to students who failed a course in the prior year, and (c) students who had eighth-grade baseline data (the most economically and academically disadvantaged subgroup). Despite the differences in subgroup characteristics, the results are very consistent across the different study samples. Taking courses online in this school district is associated (statistically significantly) with high school graduation rates that are

TABLE 3

Graduation and College Enrollment Outcomes

	School-by-cohort fixed-effects model		
	Full sample	Failed course	Eighth-grade baseline
Method and analysis sample	*N* = 39,508	*N* = 24,466	*N* = 10,925
Graduated high school	0.098*** (0.004)	0.106*** (0.005)	0.118*** (0.009)
Enrolled in college (2-year or 4-year)	0.008* (0.004)	0.023*** (0.005)	0.027*** (0.006)
Enrolled in a 4-year college or university	−0.025*** (0.003)	−0.006* (0.003)	−0.004 (0.004)
U.S. news–rated institution	−0.051*** (0.006)	−0.024*** (0.006)	−0.040*** (0.013)
Open-admissions college	0.078*** (0.011)	0.062*** (0.014)	0.092** (0.040)
Highest degree: Associates	0.015** (0.008)	0.011 (0.010)	0.012 (0.024)
Highest degree: Graduate	−0.065*** (0.008)	−0.033*** (0.009)	−0.044** (0.019)
Predominate degree: Associates	0.012 (0.008)	0.006 (0.011)	−0.009 (0.025)
Very high research activity (R1)	−0.017*** (0.004)	−0.010*** (0.004)	−0.016* (0.009)
First-year retention rate	−0.017*** (0.003)	−0.009** (0.004)	−0.019* (0.011)
Completion rate	−0.027*** (0.004)	−0.011** (0.005)	−0.010 (0.013)
School-by-cohort fixed effect	Yes	Yes	Yes
Student covariates	Yes	Yes	No
School covariates	Yes	Yes	No

Note. Standard errors in parentheses. Student covariates include whether students failed a course, the number of credits attempted, and GPA pretreatment, as well as each student's race, gender, attendance, and English language learner, special education, and free or reduced-price lunch status. School covariates include the 16 schools enrolling the largest number of students in online courses, school-by-year variables for student demographic characteristics, school type, and courses offered. GPA = grade point average.
*$p < .10$. **$p < .05$. ***$p < .01$.

about 10 to 12 percentage points higher than for similar students who do not take courses online, and their 2-/4-year college enrollment rates are also 1 to 3 percentage points higher (compared with similar students not taking courses online). The associations for *4-year* college enrollment are statistically significant and negative (except for the smaller eighth-grade baseline sample), suggesting that students taking online courses are less likely (by about 0.6-2.5 percentage points) to attend 4-year colleges. Furthermore, the signs on college quality proxy measures all suggest that while taking courses online may open access to postsecondary education for these high school students, they appear to be significantly more likely to enroll in lower quality, open-admissions institutions with poorer reputations, retention rates, and completion rates. This remains true even after adjusting for student and school characteristics and in the more restricted samples of academically struggling, highly disadvantaged students with eighth-grade baseline data.

Next, we consider associations between the intensity of student online course-taking in high school and their high school graduation and college outcomes, as estimated by the IPWRA models (see Table 4) for the full sample (Panel A), for the restricted sample of students who failed a course in the prior year (Panel B), and for a subset of these outcomes, students who had eighth-grade baseline data (Panel C).[14] The associations for high school graduation generally hold across all levels of high school online course-taking, and they are fairly consistent across the full and restricted samples and in comparison with the school-by-cohort fixed-effects models. In Panels A, B, and C, the results show that students at varying levels of online course-taking intensity are approximately 8 to 13 percentage points more likely to graduate from high school, with the most economically and academically disadvantaged (eighth grade baseline subsample) gaining more through 3 or more years of online course-taking in high school. For the outcomes of 2-/4-year college

TABLE 4

Graduation and College Enrollment Outcomes by Online Course-Taking Intensity, IPWRA Estimation: Baseline = Last Year Pre-Online Course-Taking

	Full sample (N = 33,975)		
Panel A	Enrolled in 1–2 online courses in 1–2 years	Enrolled in 3 or more online courses in 1–2 years	Enrolled in online courses in 3 or more years
Graduated high school	0.120*** (0.012)	0.127*** (0.018)	0.083*** (0.028)
Enrolled in college (2-year or 4-year)	0.026** (0.012)	−0.018 (0.019)	−0.024 (0.025)
Enrolled in a 4-year college or university	−0.019*** (0.006)	−0.078*** (0.007)	−0.028 (0.021)
U.S. news–rated institution (n = 37,494)	−0.024*** (0.006)	−0.088*** (0.008)	−0.028 (0.023)
Open-admissions college (n = 10,211)	0.080*** (0.023)	0.282*** (0.031)	0.112** (0.049)
Highest degree: Associates (n = 18,762)	0.036*** (0.012)	0.080*** (0.022)	0.026 (0.030)
Highest degree: Graduate (N = 13,241)	−0.070*** (0.014)	−0.219*** (0.024)	−0.129*** (0.027)
Predominate degree: Associates (N = 18,762)	0.040*** (0.012)	0.092*** (0.023)	0.009 (0.029)
Very high research activity (R1) (N = 18,762)	−0.024*** (0.009)	−0.071*** (0.014)	−0.045*** (0.007)
First-year retention rate	n.a.	n.a.	n.a.
Completion rate	n.a.	n.a.	n.a.
	Students who failed a course in pretreatment year (N = 24,466)		
Panel B	Enrolled in 1–2 online courses in 1–2 years	Enrolled in 3 or more online courses in 1–2 years	Enrolled in online courses in 3 or more years
Graduated high school	0.079*** (0.012)	0.113*** (0.020)	0.079*** (0.025)
Enrolled in college (2-year or 4-year)	0.012 (0.010)	−0.013 (0.013)	−0.052*** (0.013)
Enrolled in a 4-year college or university	−0.001 (0.004)	−0.014** (0.006)	−0.028*** (0.007)
U.S. news–rated institution (N = 22,847)	−0.004 (0.004)	−0.020*** (0.004)	−0.019*** (0.006)
Open-admissions college	n.a.	n.a.	n.a.
Highest degree: Associates (N = 9,477)	0.019 (0.014)	−0.019 (0.019)	−0.031 (0.019)
Highest degree: Graduate (N = 6,410)	−0.013 (0.011)	−0.089*** (0.012)	−0.085*** (0.018)
Predominate degree: Associates (N = 9,477)	0.017 (0.014)	−0.014 (0.020)	−0.048** (0.020)
Very high research activity (R1) (N = 9.477)	−0.005 (0.005)	−0.024*** (0.004)	−0.029*** (0.004)
First-year retention rate	n.a.	n.a.	n.a.
Completion rate	n.a.	n.a.	n.a.
	Eighth-grade baseline students (N = 10,925)		
Panel C	Enrolled in 1–2 online courses in 1–2 years	Enrolled in 3 or more online courses in 1–2 years	Enrolled in online courses in 3 or more years
Graduated high school	0.052*** (0.018)	0.060*** (0.019)	0.138*** (0.017)
Enrolled in college (2-year or 4-year)	0.011 (0.013)	0.004 (0.013)	0.022 (0.012)
Enrolled in a 4-year college or university	−0.007 (0.007)	−0.011 (0.007)	−0.001 (0.007)

Note. Standard errors in parentheses. Student covariates include whether students failed a course (only in Panel A models), the number of credits attempted, and GPA pretreatment, as well as each student's race, gender, attendance, and English language learner, special education, and free or reduced-price lunch status. School covariates include the 16 schools enrolling the largest number of students in online courses, school-by-year variables for student demographic characteristics, school type, and courses offered. For several measures of college quality above which estimates are not available, the IPWRA models did not converge. GPA = grade point average; IPWRA = inverse probability weighting with regression adjustment.

*$p < .10$. **$p < .05$. ***$p < .01$.

enrollment, there is a small, positive association only for students who take one to two online courses over 1 or 2 years. The associations with enrollment in 4-year colleges and universities are all negative (and some are statistically significant), generally showing small decreases (around 2 percentages points less likely to attend a 4-year college). The college quality associations are likewise very consistent with those of the school-by-cohort fixed-effects models. For the full sample, the differences in the quality of institutions attended by students with more intensive online course-taking (vs. with no online course-taking or only one to two courses in 1–2 years) are noticeably larger and mostly statistically significant. These associations again suggest that students who enrolled in high school online courses and went on to postsecondary education were significantly more likely to be enrolled in lower quality, open-access institutions and to a larger extent as they enrolled in more online high school courses and/or over more high school years.

The results of the IPWRA models estimated as a sensitivity test to the school-by-cohort fixed-effects models (shown in Appendix Table A1) largely confirm these findings. The estimates of associations between online credit recovery and high school graduation are slightly smaller, however, suggesting that students participating in online credit recovery are about 5 to 7 percentage points more likely to graduate from high school. All other estimated associations for college enrollment and college quality are the same or very similar both in the magnitude of the association and in the precision of the estimates.

Online Credit Recovery and Progress Toward High School Graduation

The associations between online course-taking and high school graduation described above suggest that the opportunity to recover failed credits online may play an important role in students' progress toward high school completion. We examined the mechanics underlying this relationship by also assessing the associations between online course-taking and the number of credits students earned and their GPAs in high school, as well as their standardized (math and reading) test scores (as a measure of learning that may predict later outcomes).

The patterns in outcomes during high school (shown in Appendix Table A2) show primarily negative, statistically significant associations of online course-taking with math and reading test scores and GPA for all students, for those who failed a course, and for those with eighth-grade baseline data. When we further restrict our sample to 11th and 12th graders who were using online credit recovery more productively (Heinrich et al., 2019), we see a positive, statistically significant association between online course-taking and credits earned, suggesting that upper class students gained about an additional 0.10 credit through online credit recovery. That said, to the extent that standardized reading and math test scores proxy well for student learning in high school and correlate with later life outcomes, as Goldhaber and Özek (2019) suggest, the potential gains in credits for high school juniors and seniors and increased likelihood of high school completion through online credit recovery observed for all students may not lead to improved later outcomes after high school.

Online Credit Recovery Program Costs

Levin and Belfield (2007, 2015) argue for greater use of cost-effectiveness analysis to inform our selection and use of the most effective educational interventions for achieving desired outcomes with a given budget. In an earlier (Levin, 1975) publication, Levin articulated a systematic approach to measuring costs and comparing them among alternatives, based on the concept of opportunity costs, or the value of a given resource in its best alternative use. In this and subsequent work (Levin & McEwan, 2001), he developed the "ingredients method" for estimating costs that involves (a) identifying the "ingredients" required to obtain a given outcome or impact (through qualitative and quantitative analysis), (b) estimating the costs of the ingredients, using market prices to the extent possible, and (c) then using this information to calculate the total program costs and average costs per participant. Although a cost-effectiveness analysis was not a formal component of our research, we identified the resources used in operating online credit recovery and information on the program costs through interviews we conducted with the study district personnel (including the credit recovery program coordinator, extended learning opportunities manager, and director of college and career readiness) and our observations of the implementation of credit recovery in schools and classrooms.

Based on the interviews and observations, we identified four main categories of costs for operating the online credit recovery program: (a) the contract (license) fees paid to the vendor of the online credit recovery program, (b) the additional personnel required to operate the program, (c) additional major material costs (e.g., computers), and (d) additional training costs for instructional personnel. The contract with the vendor costs US$350,000 per year for 850 licenses for the online course-taking system. The licenses are not assigned to individual students, but rather they allow 850 students in the district to be using the online program at any given time. With this number of licenses, we observed (over the course of our study) the district facilitating the use of the online course-taking system by as many as 7,500-plus students in a given school year. According to the district staff, the only additional personnel cost (beyond the classroom teachers who served as credit recovery lab monitors) is the credit recovery program coordinator. We were able to obtain the annual salary and benefit costs for this district employee (and teachers) through publicly available sources. In addition, district personnel indicated in the interviews that because they are a 1:1 (student to computer) district, regardless of whether students participate in online credit recovery, all students have their own laptop computers that the district provides. Thus, they did not identify any additional computing or other major material costs required to implement online credit recovery in the district. Finally, initial training on the online course-taking system is provided by the program vendor and is included in the contract costs. The district offers additional PD opportunities for use of the online course-taking system on the district's regular PD days, which was intentionally structured this way to both improve staff participation and avoid the costs of paying for training outside the school day.

District staff also pointed to cost savings associated with the use of online credit recovery relative to the primary district alternative, that is, providing students the opportunity to repeat the failed course in a regular classroom. For example, although a licensed teacher needs to be the teacher of record in an online credit recovery classroom, some schools assigned paraprofessionals to the online credit recovery classrooms that reduced instructional costs. In addition, while alternative programs for students to regain credits have specific staffing requirements such as 25:1 for competency programs and 15:1 for GED program classes, there are no staffing ratios specified for online credit recovery. We observed considerably higher student to instructor ratios in lab-style online credit recovery classrooms, including as high as 74:1 (Heinrich et al., 2019). We also documented higher than average rates of substitute teachers present in online credit recovery classrooms. In our interviews, district staff also noted that it is challenging to find teachers licensed in specific content areas for credit recovery in traditional classrooms, whereas in the online credit recovery classrooms, one teacher might monitor five different courses simultaneously across content areas, which also contributes to cost savings. Although we are not able to monetize all of the cost savings associated with different instructional staffing of online credit recovery versus traditional classrooms, the district staff we interviewed described substantial savings on instructional personnel that was realized through online credit recovery, which they indicated was critical given ongoing budget cuts in the district.

In Table 5, we summarize the online credit recovery program costs compared with the primary district alternative (providing students the option to take a failed course again in a regular classroom). These estimates suggest that the personnel (instructional staff) savings of online credit recovery lead to program costs that are approximately 50% of the cost of providing credit recovery in a traditional classroom setting or a savings of more than US$550 per student repeating an average of two courses (or more than US$4 million per year). In other words, based on our estimation, the school district is realizing increases in high school graduation rates of an estimated 5 to 11 percentage points for students who fail courses and repeat them in the online credit recovery program while simultaneously saving on the cost of offering credit recovery opportunities (by an amount that could pay

TABLE 5

Estimates of the Costs of Online Credit Recovery Relative to Course Repetition in Traditional Classroom Settings

Cost categories and total costs	Credit recovery program costs	Course repetition in a traditional classroom
Vendor contract/license costs	US$350,000/year	US$0
Program personnel (salary + benefits), credit recovery, and traditional classroom teachers	US$149,000/year for credit recovery program coordinator; US$111,000/year per instructor × 37.5 instructors[a]	US$139,000/year per additional classroom teacher × 60 teachers[b]
Additional major materials costs	US$0	US$0
Additional training costs	US$0	US$0
Total program costs	US$4,162,500	US$8,340,000
Program cost per student served (n = 7,500 students)	US$555/credit recovery participant	US$1,112 per student

[a]High school students in this district who engaged in online course-taking enrolled in an average of two online courses in a year. We use the number of approximately 7,500 student users per year, which implies approximately 15,000 student-repeated courses. We use a 40:1 student–teacher ratio (based on our classroom observation data and interviews with district staff), which leads to an estimate of 37.5 online credit recovery program instructors. The estimated salary plus fringe benefit cost of a credit recovery classroom teacher is estimated to be 20% lower than a traditional classroom teacher, given the greater use of paraprofessionals. [b]This estimate of additional teachers uses a 25:1 student–teacher ratio for 7,500 students repeating an average of two courses. The cost per teacher is the average district salary plus fringe benefit cost, US$139,000, divided by an average of five courses taught per day, or 10 courses per year, which implies 60 additional teachers. Recall that the required student–teacher ratios for other alternative program classes are 25:1 and 15:1, and this estimate also does not factor in content area teacher instructional needs; thus, this is likely a conservative estimate.

for approximately 30 additional classroom teachers per year).

In his analysis to estimate the costs of various interventions used to increase high school graduation rates, Levin (2009) identified that a class-size reduction during grades K–3 (of 25:1 to 15:1) would cost US$13,100 per student in 2004 dollars (or over US$17,000 per student in 2020 dollars) and would lead to 11 additional graduates per 100 students. He also calculated that a 10% salary increase for K–12 teachers in all years would lead to five additional graduates per 100 students at the cost of about US$4,000 per student in 2020 dollars. As indicated above, we estimated increases in graduation rates (associations) of 5 to 11 percentage points through online credit recovery *for students who had failed a course* (compared with the option of having students repeat courses in traditional classrooms) that costs about US$550 per student and generates cost savings relative to the "status quo." This suggests that online credit recovery may be about 8 to 30 times more cost-effective in raising graduation rates than these two alternative interventions identified by Levin (2009). However, it is important to keep in mind that this only applies to this specific outcome (high school graduation), and we found negative associations between online credit recovery and student standardized test scores and with 4-year college enrollment and college quality.

Discussion and Conclusion

The growing use of online course-taking for credit recovery in U.S. high schools raises concerns about how public schools are responding to accountability pressures to raise high school graduation rates through an expanding role for private vendors in the delivery of core curricular content and instruction online. Through the lens of new institutionalism, credit recovery programs provide a relatively inexpensive technical solution to the problem of course failure that sets high school students behind for graduation, particularly those who have struggled academically and with problems outside of school that heighten their risk of "disappearing from the educational pipeline before graduating" Orfield et al. (2004: 2).

Our empirical examination of associations between online course-taking (primarily for credit recovery) and high school graduation rates in a large urban school district suggests that if a cheap "technical fix" to the challenge of increasing credits earned and high school completion is desired, online credit recovery may work more efficiently than traditional options for repeating failed courses. That is, we find positive associations between high school online course-taking and graduation, ranging from about 5 to 13 percentage points, depending in part on the intensity of online course-taking. These estimates correspond fairly closely with the rise in graduation rates we saw in our study district over this same period. In fact, our analysis suggests an almost mechanical relationship that may work mainly for upper classmen, who are able to replace failed courses with online credits earned more quickly—an increase of approximately 0.10 credits in a given year—and more cost-efficiently online. Our crude cost-effectiveness analysis suggested that online credit recovery may cost half of what is required to offer students the opportunity to repeat courses in the traditional classroom, and it is substantially less costly than other interventions identified as increasing high school graduation rates.

In our study district, we have also found increasing proportions of students taking and passing online course pretests—which allow students to "test out of" and bypass some or all parts of online course instruction (and thereby complete courses in fewer sessions)—rising from about one-quarter of students in the first years of online course-taking to about two-thirds of students in recent school years (Heinrich et al., 2019). This use of online instructional programs is congruent with the goals of new institutionalism, which in principle value efficiency over more holistic learning outcomes (Meyer & Rowan, 2006). It is incompatible, however, with the move toward a more "holistic" evaluation of school quality and student success necessary to achieve goals of educational equity and social justice. Indeed, our results reveal mostly negative and statistically associations between online course-taking and student performance on standardized math and reading tests, which is consistent with reports of stagnating high school student performance on NAEP tests as high school graduation rates have risen. Our related research (Darling-Aduana et al., 2019; Heinrich et al., 2019) that reports in depth on our classroom observations of online course-taking likewise engenders concern that the quality of learning opportunities may be poorer in these settings, which we found were lacking in live teacher interactions, content learning support, accommodations for students with special needs, and adequate student–teacher ratios. These findings and the broader, accumulating evidence base on credit recovery programs raise the question of whether the goal embedded in policies such as North Carolina's, which articulates that the length of a credit recovery course should be "dictated by the skills and knowledge the student needs to recover," is being pursued in practice. If school districts value equity and quality in educational opportunities and outcomes, they need to allocate more resources toward providing the types of instructor and student supports that will contribute to more effective content learning online and to preparing students for continuing education and success beyond high school.

In fact, in following students after high school and examining their postsecondary education options, we do find some small, statistically significant, positive associations between high school online course-taking and college enrollment (of about 2%), but mainly for those with very limited online course-taking, that is, no more than one to two courses over 1 to 2 high school years. If we believe that even small potential increases in college enrollment are worth the trade-offs described above in the quality of learning we observed in online course-taking, then online credit recovery programs that may increase the likelihood of graduation for a predominately lower performing student population might be valued for opening the door for students to postsecondary education opportunities. However, we find only negative, statistically significant associations between online course-taking (of all levels of intensity) and 4-year college enrollment across each of our student samples. In addition, we also find that students who took courses online in high school enrolled in poorer quality postsecondary institutions, with lower average retention and completion rates, which casts some doubt on whether they will realize long-term benefits from these investments.

Finally, we conclude by reiterating some of the limitations of our research design and analysis. We acknowledge that these findings are based on data from a single, large urban school district, and while it shares many characteristics with other large urban school districts using this same vendor-developed online instructional program (e.g., high poverty rate, largely serving students of color, and low resources), we do not make claims about the generalizability of these findings to similar school districts in the United States. In addition, although we have employed rigorous quasi-experimental methods in our analyses, the usual threats about unobserved selection into treatment (online course-taking), attrition in our outcome measures, and other data errors preclude us from making any causal assertions about online credit recovery programs and the student outcomes we investigate.

Appendix

TABLE A1

Alternative Estimation of Graduation and College Enrollment Outcomes

	IPWRA	
Method and analysis sample	Full sample	Failed course
Overall sample size	*N* = 39,508	*N* = 24,466
Graduated high school	0.071*** (0.005)	0.049*** (0.007)
Enrolled in college (2-year or 4-year)	0.0004 (0.004)	0.002 (0.006)
Enrolled in a 4-year college or university	−0.018*** (0.002)	−0.004 (0.003)
U.S. news–rated institution	−0.034*** (0.002)	−0.011*** (0.002)
Open-admissions college	0.078*** (0.009)	0.052*** (0.012)
Highest degree: Associates	0.026*** (0.007)	0.014 (0.010)
Highest degree: Graduate	−0.043*** (0.006)	−0.023** (0.007)
Predominate degree: Associates	0.031*** (0.007)	0.015 (0.010)
Very high research activity (R1)	−0.019*** (0.002)	−0.007** (0.002)
First-year retention rate	−0.016*** (0.002)	−0.009** (0.003)
Completion rate	−0.024*** (0.003)	−0.016*** (0.005)

Note. Standard errors in parentheses. Student covariates include whether students failed a course, the number of credits attempted, and GPA pretreatment, as well as each student's race, gender, attendance, and English language learner, special education, and free or reduced-price lunch status. School covariates include the 16 schools enrolling the largest number of students in online courses, school-level student demographic characteristics (by year), school type, and courses offered. GPA = grade point average; IPWRA = inverse probability weighting with regression adjustment.
$^{*}p < .10$. $^{**}p < .05$. $^{***}p < .01$.

TABLE A2

Associations of Student High School Outcomes with Online Credit Recovery

	IPWRA estimation			
Method and analysis sample	Full sample	Failed course	Eighth-grade baseline	11th- and 12th-grade failed course
Sample size	*N* = 73,403	*N* = 34,944	*N* = 24,644	*N* = 8,237
Math test scores (standardized)	−0.053*** (0.008)	−0.034*** (0.009)	−0.048*** (0.013)	−0.057*** (0.017)
Reading test scores (standardized)	−0.091*** (0.013)	−0.034*** (0.013)	−0.052*** (0.019)	−0.068*** (0.025)

(continued)

TABLE A2 (CONTINUED)

Method and analysis sample	IPWRA estimation Full sample	Failed course	Eighth-grade baseline	11th- and 12th-grade failed course
Sample size	N = 79,235	N = 45,980	N = 34,870	N = 20,464
High school credits earned	−0.034 (0.025)	0.022 (0.023)	−0.309*** (0.060)	0.101** (0.036)
Sample size	N = 90,182	N = 45,735	N = 40,021	N = 19,894
High school grade point average	−0.039*** (0.008)	−0.014* (0.007)	−0.032*** (0.014)	−0.002 (0.011)

Note. Standard errors in parentheses. Student covariates include whether students failed a course, the number of credits attempted, and GPA pretreatment, as well as each student's race, gender, attendance, and English language learner, special education, and free or reduced-price lunch status. School covariates include the 16 schools enrolling the largest number of students in online courses, school-level student demographic characteristics (by year), school type, and courses offered. GPA = grade point average; IPWRA = inverse probability weighting with regression adjustment.
*$p < .10$. **$p < .05$. ***$p < .01$.

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Notes

1. The National Assessment of Educational Progress (NAEP) is the largest ongoing, nationally representative assessment of student math and reading achievement (see https://nces.ed.gov/nationsreportcard/).

2. See: https://nces.ed.gov/fastfacts/display.asp?id=51.

3. https://www.nrms.k12.nc.us/cms/lib011/NC01800012/Centricity/Domain/64/gcs_m001.pdf

4. In a related work (Heinrich et al., 2019), we show that the subsample of data with matched student record-technology vendor data is representative of all students taking courses online in this school district.

5. We also explored dose–response modeling with a continuous treatment measure of online course-taking, but we decided not to present this as our primary approach to modeling treatment intensity because the confidence intervals for the estimates at higher levels of online course-taking grew very wide (imprecise).

6. MAP and STAR are nationally normed standardized assessments that the school district administers locally in certain grades. Because the district transitioned from MAP to STAR during the course of the study, and to aid interpretation, we used standardized scores in the analysis as a means of equating scores from one year to the next.

7. We do not restrict our measure of high school completion to those who graduate in 4 years because whether (vs. when) students earned their diploma was of greater interest in this study. Furthermore, data on students' first year in the district were missing for many students, making an accurate calculation of the 4-year graduation rate possible only with a restricted sample.

8. To track how many of their students go on to college and where, high schools use StudentTracker®

reports from the NSC Research Center, which were created to enable schools to measure their effectiveness in supporting student postsecondary education success: https://nscresearchcenter.org/workingwithourdata/.

9. https://collegescorecard.ed.gov/data/

10. There are many well-known limitations to describing the U.S. News and World Report (USNWR) indicators as *quality* measures of postsecondary institutions, including the concern that they can be "gamed" by institutions that take actions to raise their measured performance without increasing quality. For a more in-depth discussion, see O'Neill (2016).

11. https://wisedash.dpi.wi.gov/Dashboard/portalHome.jsp.

12. If all students were enrolled in the district for each of 4 years of high school and had attended only one high school, giving us data on each student for each year of high school enrollment, then the school measures included in our models would be identical among students in the same school-by-cohort group. However, with considerable variation among students in the number of years of data available for their time in high school and relatively high rates of transfer between high schools, these variables were not always constant across students in the same school-by-cohort. Thus, the inclusion of these variables aims to control for (to the extent possible) differences in assignment to online course-taking and other school-based variations in school experiences not associated with online course-taking.

13. As in the analysis of online course-taking intensity, data for the eighth-grade baseline subsample were limited for estimating college quality outcomes for this smaller subsample. The models estimated for only the high school graduation and two college enrollment outcomes showed patterns in associations very similar to those of the school-by-cohort fixed-effects models (results available from the authors).

14. Only 157 students with eighth-grade baseline data attended institutions that were rated in USNWR, and consequently, the inverse probability weighting with regression adjustment (IPWRA) models on college quality outcomes did not converge.

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