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Technical Report

Quasi-experimental study of Connections GradPoint: how taking a credit recovery course in GradPoint leads to better learner outcomes than repeating a failed original credit course.

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Executive Summary

Overview of Connections Academy Schools and Connections GradPoint

Connections Academy schools are public schools that provide tuition-free, online, full-time, college-preparatory education for K-12 students. Most Connections Academy schools are accredited by one of the six regional accreditation organizations. Students attending Connections Academy schools are looking for educational options beyond their local school system. The schools serve a variety of students including those looking to be challenged, trying to catch up, with health concerns, wanting flexibility to accommodate athletic or performance schedules, have accessibility issues, are being bullied, or are otherwise dissatisfied with local bricks-and-mortar options.

Many students enroll in a Connections Academy credit-deficient and are, therefore, unlikely to graduate on time. To help those students catch up, Connections Academy schools began offering GradPoint online credit recovery courses during the 2015-16 school year, rather than having students repeat the full course. The intention was to allow students to master the academic content required to be successful in high school and beyond, while also helping them stay on track, or get back on track, for timely graduation, by accelerating the rate at which they could recover credits.

Connections GradPoint is a diagnostic-prescriptive, skills-targeted, teacher-supported credit recovery program that has the advantage of not being as time-intensive as re-taking the full course. It can help students in grades 9 to 12 get back on track for graduation.

GradPoint credit recovery courses appeared to be a very viable solution for credit-deficient students, and as an online option meshed very well with the Connections Academy online schools. Connections nevertheless wanted research-based evidence of whether GradPoint was a more effective solution than having students repeat the full original credit course.

Prior to the 2015-16 school year, a small number of Connections Academy schools had used GradPoint for credit recovery with promising results. This prompted Connections to expand the availability of GradPoint credit recovery courses – and to design a research study to assess whether taking a GradPoint course was indeed more effective than repeating a failed original credit course. In this study, we assessed the impact both in terms of course pass rates and students' acquisition of knowledge.

Research Questions

This study assessed the relative impact of two Connections Academy credit recovery options on student academic achievement. Traditionally, if students failed a core course, the only way to recover credits was to repeat that course. Beginning in 2015-16, students could choose instead to take a corresponding Connections GradPoint course. The aim of this study was to assess whether taking a GradPoint course

was indeed more effective than repeating a failed original credit course. The following research questions were addressed:

Impact on course pass rates

RQ1: Are GradPoint students more likely to pass their credit recovery course and recover lost credits than a matched comparison group of original credit course repeaters?

Impact on students' subject knowledge of area content

RQ2: Do students taking GradPoint courses perform as well on state tests in the subject area (Math, English) as students repeating original credit courses ?

Method

Methods for research question one (RQ1)

This rigorous impact evaluation involved two key analysis steps. First, a propensity score-matching analysis (one-to-one nearest neighbor matching) was conducted to identify a comparison group of original credit course repeaters. These repeaters were as similar as possible to the sample of GradPoint students in terms of prior academic achievement and demographic and enrollment characteristics. After this sample matching step, we then conducted multi-level regression analyses to assess the effect of credit recovery options (taking a GradPoint course versus repeating an original credit course) on multiple learner outcome measures. We statistically adjusted for any residual differences in achievement-related factors between the treatment and comparison groups after propensity score-matching.

- **Data source:** This study used Connections Academy credit recovery enrollment data from the 2015-16 academic year, the inaugural year of GradPoint as a credit recovery mechanism. There were two learner outcome measures of interest: (i) whether students earned a passing/failing grade in their credit recovery course, and (ii) students' standardized state test scores in the subject area for which credit recovery was sought.
- **Propensity score-matching:** To identify a comparison group against which to evaluate the effectiveness of GradPoint, we conducted a one-to-one nearest neighbor *propensity score-matching analysis*, which matched each GradPoint student to a corresponding original credit course repeater who was as similar as possible in terms of the following nine achievement-related dimensions:
 - Student prior achievement
 1. Students' cumulative GPA (grade point average) prior to enrolling in the credit recovery course

- Student demographic characteristics
 2. Race
 3. Gender
 4. ELL status (English language learner or not)
- Enrollment characteristics
 5. On-time versus late enrollment
 6. New versus returning Connections Academy student
 7. IEP status (on an individualized education plan during 2015-16 or not)
 8. Course for which credit recovery was sought
 9. Connections Academy school/location.
- **Analytic sample from propensity score-matching:** The propensity score-matching analysis yielded a sample of 4,876 Connections Academy course enrollments from the 2015-16 academic year: a treatment group of 2,438 GradPoint course enrollments (from 1,390 unique students), and a comparison group of 2,438 repeated original credit course enrollments (from 2,013 unique students).
- **Baseline equivalence:** The propensity score-matching analysis succeeded in establishing *baseline equivalence* between the treatment and comparison groups along six of the nine achievement-related dimensions: student prior achievement, gender, status as an English language learner, enrollment status, enrollment time, and IEP status. Due to a limited sample size, since only one academic year's worth of credit recovery enrollments was available for this study, the matching analysis reduced, though did not fully eliminate, asymmetries between the treatment and comparison groups in terms of course enrollment and Connections Academy school/location. Also, the research team was not able to achieve baseline equivalence for one ethnic group (African American) according to What Works Clearinghouse standards for baseline equivalence (WWC Standards Handbook Version 4.0, p14).
- **Comparison of GradPoint students to matched original credit course repeaters:** After identifying a matched comparison group of original credit course repeaters through the steps above, the effectiveness of GradPoint was then assessed by using multi-level (mixed effects) regression analyses to compare GradPoint students to repeaters on course pass rates . The matching variables listed above were included as statistical control variables in the analysis to adjust for any differences that remained between the GradPoint students and original credit course repeaters after propensity score-matching.

Methods for research question two (RQ2)

This study used a retrospective cohort design to assess whether students enrolled in GradPoint courses tended to perform similarly on state tests compared to students repeating original credit courses. Possible confounding factors were controlled for by adding covariates to the statistical model. These factors were prior cumulative GPA, course content (i.e., Math or English), and course level (i.e., English 1-4, Pre-Algebra, Algebra 1 and 2, Geometry).

Analysis approach: To compare state test achievement between GradPoint courses and original credit course repetitions, performance levels were analyzed using probit (latent) ordinal regression. Variables indicating the subject area, course level and prior GPA were included in this analysis to statistically control for difference in these factors between the groups. Prior GPA was missing for 41.6% of the sample. Multiple imputation was used to create 100 imputed datasets using subject area, course level, course score and state test performance category to predict the missing prior GPAs.

Key Findings

RQ1: Course pass rates – comparative conclusions based on quasi-experimental design

- **Adjusted course pass rates were 40 percentage points higher, on average, for GradPoint enrollments – or nearly twice as high – compared to a matched sample of original credit course repetitions.** After controlling for a wide range of achievement-related factors, including students' prior achievement, demographic background and course enrollment characteristics, the overall adjusted pass rate for students enrolled in a GradPoint credit recovery course was 85%, compared to only 45% for students enrolled in an original credit course repetition.
- **In terms of adjusted course pass rates, the *average* GradPoint student, who had a GPA of ~1.7, outperformed original credit course repeaters who had considerably higher prior achievement.** While the *average* pass rate for a typical student enrolled in a GradPoint course was 85%, the adjusted pass rate for original credit course repetitions only reached that level for original credit course repeaters with a prior GPA of 3.4 or higher (see Figure 6).
- **Nearly *all* GradPoint students, including historically low-achieving students, outperformed the *average* original credit course repeater.** While the adjusted pass rate for a typical student enrolled in an original credit course repetition was 45%, nearly all GradPoint students had an adjusted pass rate at or above that level. In particular, historically lower-achieving students with a GPA of ~1.0 who sought credit recovery via GradPoint had an adjusted course pass rate of ~71%, with pass rates increasing to 90% or higher among GradPoint students with at least a 2.0 GPA (see Figure 6).

- **Not only did taking a GradPoint course lead to higher adjusted pass rates – and hence higher credit recovery rates – GradPoint courses also reduced a discrepancy between new versus returning Connections Academy students.** Specifically, pass rates for original credit course repetitions were significantly lower among new Connections Academy students (average pass rate of 38%) than among returning Connections Academy students (average pass rate of 49%). By contrast, there was no significant difference between new and returning Connections Academy students who sought credit recovery through GradPoint: both student groups had a pass rate of 85% in their GradPoint credit recovery courses. (See Figure 7).

RQ2: Students' subject knowledge of area content – relational conclusions

There was no statistically significant difference in performance between those students who passed GradPoint and those who passed the repeated standard course offering in English or Math.

A correlational analysis using a sample of students who were successful in their credit recovery in English or Math revealed that GradPoint students tended to have similar subject knowledge as measured by their subsequent performance on English and Math state tests. After controlling for prior GPA, subject area and course level, there was no statistically significant difference in performance between students who passed GradPoint and those who passed the repeated standard course in English or Math.

Recommendations

Future research could attempt to validate the impact of taking a GradPoint course on students' knowledge of subject area content. For the current study, we only had reliable student achievement data for two subjects - math and reading. While the preliminary results from Part 1 were suggestive, it is unclear whether these results are robust (due to a limited sample size) and whether these findings would generalize to subject areas other than math and English. Thus, further research is needed to understand the impact of GradPoint on student learning across the range of credit recovery course offerings.

Given the current data, we were able to identify schools and courses that showed a larger or smaller GradPoint advantage than average. However, we were not able to assess what caused this variability. Future research could investigate the combination of contextual, implementation-level and/or school-specific factors that affect the size of the GradPoint advantage across schools and courses in order to understand the conditions that maximize the impact of taking a GradPoint course on learner outcomes.

Introduction

This study assessed the relative impact of two Connections Academy credit recovery options on student academic achievement. Traditionally, if Connections Academy students failed an original credit course, either at their previous school or at a Connections Academy school, the only mechanism for credit recovery was to repeat that course. Beginning in 2015-16, students could alternatively take a corresponding Connections GradPoint course. Since Connections GradPoint was a new program at Connections Academy schools, and was designed specifically to assist with credit recovery, the goal of this study was to assess whether taking a GradPoint course was more effective than repeating a failed original credit course. We assessed impact in terms of course pass rates – and hence overall credit recovery rates – and in terms of students' acquisition of subject area knowledge.

Background

Currently, there is no federal definition, organization or oversight regarding credit recovery (Kirsch, 2017). It is left to states to regulate, and in most cases the responsibility falls to school districts to define credit recovery and to oversee credit recovery efforts. Many schools and districts, including Connections Academy schools, generally define credit recovery students as those students who have failed a credit-bearing course and need to re-do coursework, or retake a course, to make up the credit. These students are often faced with a variety of challenges, both personal and academic, that put them at risk of not graduating on time, or at all. These can include health concerns, stressful family or personal situations, stressful school conditions (i.e., bullying or safety issues), and/ or a need for additional academic support.

Students choosing to enroll in Connections Academy schools are looking for educational options beyond their local public school system, often because it has not served their specific needs well. Not surprisingly, many of these students are credit deficient – and therefore off-track for timely graduation – when they enroll in a Connections Academy school. Before the 2015-16 school year, Connections Academy students needing to make up credits had to retake the full course, either as a summer school or academic year course. This took the same amount of time, or only slightly less, than taking the course the first time, which meant a student might not graduate on time even if they eventually passed the course and earned credit.

GradPoint's online diagnostic/prescriptive credit recovery courses include diagnostic tests that allow students to quickly demonstrate what course content they have already mastered. They can then move on to learning content they have not yet mastered. This credit recovery course format allows students to potentially recover the credit more quickly than if they had to repeat the entire course.



During the 2014-15 school year, a small number of Connections Academy schools piloted GradPoint to help credit-deficient students make up credits. The pilot showed promising results, and the majority of Connections Academy schools began offering GradPoint as a credit recovery option during the 2015-16 school year.

While GradPoint's online credit recovery courses appeared to be a viable solution for Connections Academy's credit-deficient students, Connections nevertheless wanted research-based evidence for whether GradPoint was indeed effective. So, at the same time as Connections expanded the GradPoint credit recovery course offerings to all interested Connections Academy schools, a research study was designed to assess whether taking a GradPoint course was as effective as repeating a failed original credit course.

The ultimate goal for all Connections Academy schools is student success, both academic and personal. This study, therefore, assessed impact both in terms of course pass rates (increasing the possibility of graduating on time) and students' acquisition of knowledge (being prepared for success beyond high school).

Description of Connections Academy and Connections GradPoint

Connections Academy schools are public schools that provide tuition-free, online, full-time, college-preparatory education for K-12 students. Most Connections Academy schools are accredited by one of the six regional accreditation organizations. Students attending Connections Academy schools are looking for educational options beyond their local school system. The schools serve a variety of students including those looking to be challenged, trying to catch up, with health concerns, wanting flexibility to accommodate athletic or performance schedules, have accessibility issues, are being bullied, or are otherwise dissatisfied with local bricks-and-mortar options.

Connection Academy Schools offer a personalized learning experience to students tailored to their individual needs via a virtual online system that is accessible anywhere with internet access. (Connections Academy, 2016). Teachers are the foundation of the Connections Academy experience. They are talented, passionate, certified and specially trained in online teaching. Teachers get to know the learning style, skills and interests of each student so they can give every student the best opportunity to excel. The Connections Academy approach also allows students to accelerate learning in areas of strength or receive extra attention in areas of weakness.

Connections Academy's education management system, Connexus®, lets students access a collaborative learning experience anywhere they have an internet connection. Assessment and reporting tools, digital curriculum materials, multimedia curriculum tools and games, and clubs and activities are all available to Connections Academy students at no charge. LiveLesson allows teachers to lead real-time interactive

and adaptive classes online. Students interact with their teachers, learning coaches (i.e., parents) and the community through experiences organized to provide social interaction with peers and adults.

GradPoint is offered at Connections Academy schools as an online credit recovery option for students in grades 9 to 12 who have failed the original credit course. By allowing students to focus their time on only the skills they have not yet mastered, GradPoint offers a more efficient solution for students who need to repeat a course. The GradPoint course first assesses student knowledge of each objective with a pre-test. Then, lessons are systematically assigned to the student based on the objectives for which the student did not demonstrate mastery in the pretest. Students take the prescribed lessons and are then presented with a post-test to assess objective-level knowledge. When students pass the 80% threshold, the module is considered complete and the student can progress to the next module.

The Present Study

Course fail rates and graduation rates are an area of concern in many schools and districts, including Connections Academy schools. During the 2015-16 academic year, 23% of all completed Connections Academy course enrollments resulted in a failing grade. Fail rates were higher than 20% in several subject areas, including Math, Biology, English, Physical Science, Geography, Earth Science and History. Fail rates in Math were the highest overall (32% of completed first attempts).

Figure 1: Course fail rate by subject area from 2013-14 to 2015-16.

If students do not earn a sufficient number of credits in each required subject area, they are not eligible to graduate. So, with nearly one in four completed course enrollments resulting in a failing grade during 2015-16, along with the reality that many students are already credit-deficient when they initially enroll at a Connections Academy school, it is important to have effective solutions in place to help students recover these lost credits and get back on track for timely graduation.

This study assessed the relative impact on learner outcomes of two Connections Academy credit recovery options. Traditionally, if students failed a course, the only way to make up the credit (credit recovery) was to repeat that course. Beginning in 2015-16, students could instead take a corresponding Connections GradPoint course. Since Connections GradPoint was a new option for Connections Academy students, and is designed specifically to assist with credit recovery, the goal of this study was to assess whether taking a GradPoint course was indeed more effective than repeating a failed original credit course.

The following research questions were addressed:

- Does taking a credit recovery course in GradPoint lead to better academic achievement than repeating a failed original credit course, after controlling for a wide range of student

achievement-related factors, including student prior achievement, demographics, and enrollment factors? We addressed this question in terms of two learner outcomes:

- **Impact on course pass rates:** Are students in GradPoint courses more likely to pass their credit recovery course and recover lost credits than a matched comparison group of original course repeaters?
- **Impact on students' knowledge of subject area content:** Do students passing GradPoint courses have similar English and Math state test performance as those passing repeated English or Math courses?
- If there is an apparent benefit of GradPoint over repeating an original credit course, does the size of this 'GradPoint advantage' vary across schools and/or courses?
- For students seeking credit recovery in Math (the hardest subject overall, as indicated by course fail rates), is the apparent benefit of GradPoint mediated by whether students are enrolled in additional Math supplements (e.g., MathXL or Think Through Math)?

As far as possible, we addressed these research questions using a quasi-experimental design that affords comparative conclusions about the relative impact of taking a GradPoint course versus repeating a failed course on learner outcomes. Some of these research questions, however, could only be addressed via exploratory correlational analyses due to data limitations. In the text below, we clearly identify whether each analysis affords comparative conclusions about impact or is instead correlational/observational in nature. Note, however, that even in the case of exploratory correlational analyses, we endeavored to be as conservative as possible by statistically adjusting for a wide range of student and course characteristics that might contribute to observed differences between the sample of GradPoint students and original credit course repeaters.

Method

This study used a quasi-experimental design to assess the impact of taking a GradPoint credit recovery course on learner outcomes, relative to repeating a failed original credit course. This design involved two key steps. First, a propensity score-matching analysis was conducted to identify a comparison group of original credit course repeaters who were as similar as possible to the sample of GradPoint students – including similar prior academic achievement, demographics and enrollment characteristics. After this sample-matching step, we then conducted multilevel regression analyses to assess the effect of credit recovery options (taking a GradPoint course versus repeating an original credit course) on multiple learner outcome measures, while statistically adjusting for any residual differences in achievement-related factors that remained between the treatment and comparison groups after propensity score-matching.

Participants

The 2015-16 academic year was the first year of Connections GradPoint as a credit recovery option. Therefore, participants in this study were identified from the sample of GradPoint students in 2015-16 and from the sample of students who opted instead to repeat a failed original credit course during 2015-16. Course repetitions were determined using student enrollment histories dating back to the 2013-14 academic year – a 2015-16 course enrollment was counted as a repetition if the student had previously attempted that course at any point back to Fall 2013.

Counting both GradPoint and repeated failed course enrollments, there were a total of 15,198 credit recovery enrollments during 2015-16, which represents 5% of the nearly 300,000 Connections course enrollments that year. These enrollments were split fairly evenly between the two credit recovery options: 8,142 of these enrollments (or 54%) involved repeating a course, and 7,056 of these enrollments (or 46%) involved taking a GradPoint credit recovery course. At the time of this study, however, only about half of all credit recovery students (8,120) had completed the course (see Table 1): specifically, 2,802 (or 39.7% of) GradPoint enrollments, and 5,318 (or 65.3% of) original course repetitions.

Table 1: Overview of 2015-16 credit recovery course enrollments by completion status

Stage	Original credit repetitions	Original credit percentage	GradPoint enrollments	GradPoint percentage
Complete	5,318	65.3%	2,802	39.7%
In progress	622	7.6%	2,361	33.5%
Incomplete/ dropped/withdr awn	2,202	27.0%	1,893	26.8%
Total:	8,142	100.0%	7,056	100.0%

Because the goal of this study was to assess the impact of taking a GradPoint course on learner outcomes – namely course pass rates – relative to repeating a failed original credit course, participation in this study was necessarily limited to credit recovery enrollments that were complete at the time of this study (i.e., enrollments for which pass/fail data were available). Therefore, the 8,120 completed enrollments served as the initial sample for this study. A one-to-one nearest neighbor propensity score-matching analysis was then conducted to match each GradPoint student in this initial sample to an original credit course repeater who was as similar as possible along the following nine achievement-related dimensions:

- Student prior achievement
 1. Students' cumulative GPA prior to enrolling in the credit recovery course
- Student demographic characteristics
 2. Race
 3. Gender
 4. ELL status (English language learner or not)
- Enrollment characteristics
 5. On-time versus late enrollment
 6. New versus returning Connections Academy student
 7. IEP status (on an individualized education plan during 2015-16 or not)
 8. Course for which credit recovery was sought
 9. Connections Academy school/location.

After propensity score-matching, the final analytic sample comprised 4,876 Connections Academy student enrollments: 2,438 GradPoint enrollments (from 1,390 unique students) – the full set of completed GradPoint enrollments for which all matching variables were available – and a matched comparison group of 2,438 repeated original credit course enrollments (from 2,013 unique students).

Data Collection

All data for this study came directly from Connections Academy, including (i) student grade data for their 2015-16 course enrollments; (ii) student demographic characteristics; (iii) student enrollment histories dating back to 2013-14, which were needed to identify course repetitions, and (iv) school characteristics, including school-specific grading standards, which were needed to determine passes versus fails.

Measure: Pass versus fail

The primary outcome measure for this study was whether students passed or failed their credit recovery course. Passing a course is commensurate with credit recovery. That is, although individual courses vary in terms of their credit value (the majority are worth a half credit, but some are worth a quarter credit or one credit), students earn the full credit value of the course as long as they achieve a passing grade. So, by using course pass rates as the outcome measure of interest, we were able to assess whether GradPoint courses were more effective at helping students recover lost credits – relative to repeating an original credit course – while removing the complexity resulting from individual courses having different credit values.

Impact of taking a GradPoint course on subject area knowledge (RQ2)

As well as assessing the impact of GradPoint on learner outcomes at the level of course pass rates – and hence overall credit recovery – we also endeavored to assess learner outcomes at the level of a student's knowledge of course content.

Design. This study used a retrospective cohort design to assess whether students enrolled in GradPoint courses tended to perform as well in state tests as students repeating original credit courses. Possible confounding factors were controlled for and added to the statistical model as covariates. These factors were cumulative GPA, course content (i.e., Math or English) and course level (i.e., English 1-4, Pre-Algebra, Algebra 1 and 2, Geometry).

Participants. There were 296 cases in 2015-16 (GradPoint = 159, original credit course repeaters = 137) where an English or Math course was repeated, completed and passed, and the student was subsequently state tested. These cases were included in this analysis. It should be noted that more GradPoint students repeated English (71%), while Math was more often repeated with an original credit course (87%).

Analysis approach. To compare state test achievement between GradPoint courses and original credit course repetitions, performance levels were analyzed using probit (latent) ordinal regression. Variables indicating the subject area, course level, and prior GPA were included in this analysis to statistically

control for difference in these factors between the groups. Prior GPA was missing for 41.6% of the sample. Multiple imputation was used to create 100 imputed datasets using subject area, course level, course score, and state test performance category to predict missing prior GPAs.

An ordinary general linear fixed effects model was employed along with a naïve covariance structure within a robust empirical standard error formulation (i.e., sandwich estimator with the traditional model-based estimator as the 'bread' in the sandwich). This covariance structure included Connections school as the independent unit and students nested within schools. This procedure results in estimates that are unbiased and statistical hypothesis tests that are consistent despite the complex nested nature of the data.

Results

The primary goal of this study was to assess the relative impact on learner outcomes of taking a GradPoint course versus repeating an original credit course. Before presenting the results of this impact evaluation, we first present a descriptive overview of the credit recovery enrollments from 2015-16. Against this background, we then present the results of the propensity score-matching analysis, and we assess the extent to which this matching procedure succeeded in establishing baseline equivalence between the treatment sample of GradPoint students and the comparison group of course repeaters. Finally, after identifying and justifying our analytic sample, we present the results of our impact evaluation.

Demographic overview of credit recovery seekers (2015-16)

Table 2 summarizes the cumulative prior GPA of students across the 2015-16 credit recovery enrollments. The average (mean and median) GPA was ~1.4.

Table 2: Summary of students' prior cumulative GPA for all credit recovery enrollments in 2015-16

Mean	SD	Median	25 th percentile	75 th percentile
1.44	0.78	1.42	0.88	1.95

Note: Descriptive statistics are at the enrollment level. Students are counted multiple times if they were enrolled in multiple credit recovery courses during 2015-16. N = 13,210 (of the 15,198 credit recovery enrollments during 2015-16, students' prior semester GPA was unavailable for 1,988).

Table 3 provides an overview of the student demographics for all 15,198 credit recovery enrollments during 2015-16. The majority of these enrollments were by white students, who enrolled in Connections Academy on time, who were native speakers of English and who were not on an individualized education plan (IEP) during the 2015-16 year. Note that credit recovery enrollments were approximately evenly balanced between new and returning Connections Academy students and between male and female students (with slightly higher enrollments by female students).

Table 3: Overview of student demographic characteristics for all credit recovery enrollments during 2015-16

Variable		N	%
Race			

	White	9,442	62.1%
	Hispanic or Latino	2,377	15.6%
	Black/African American	2,030	13.4%
	Multiple races	863	5.7%
	American Indian or Alaskan Native	195	1.3%
	Asian	180	1.2%
	Unknown	76	0.5%
	Native Hawaiian or other Pacific Islander	35	0.2%
	Total	15,198	100%
Gender			
	Female	8,388	55.2%
	Male	6,734	44.3%
	Unknown	76	0.5%
	Total	15,198	100%
ELL status			
	Native English speaker	14,929	98.2%
	English language learner	193	1.3%
	Unknown	76	0.5%
	Total	15,198	100%
Enrollment time			
	On-time	9,145	60.2%
	Late	5,977	39.3%
	Unknown	76	0.5%
	Total	15,198	100%
Enrollment status			
	Returning Connections Academy student	7,565	49.8%

	New Connections Academy student	7,557	49.7%
	Unknown	76	0.5%
	Total	15,198	100%
IEP status			
	Not on an IEP during 2015-16	13,537	89.1%
	IEP	1,661	10.9%
	Total	15,198	100%

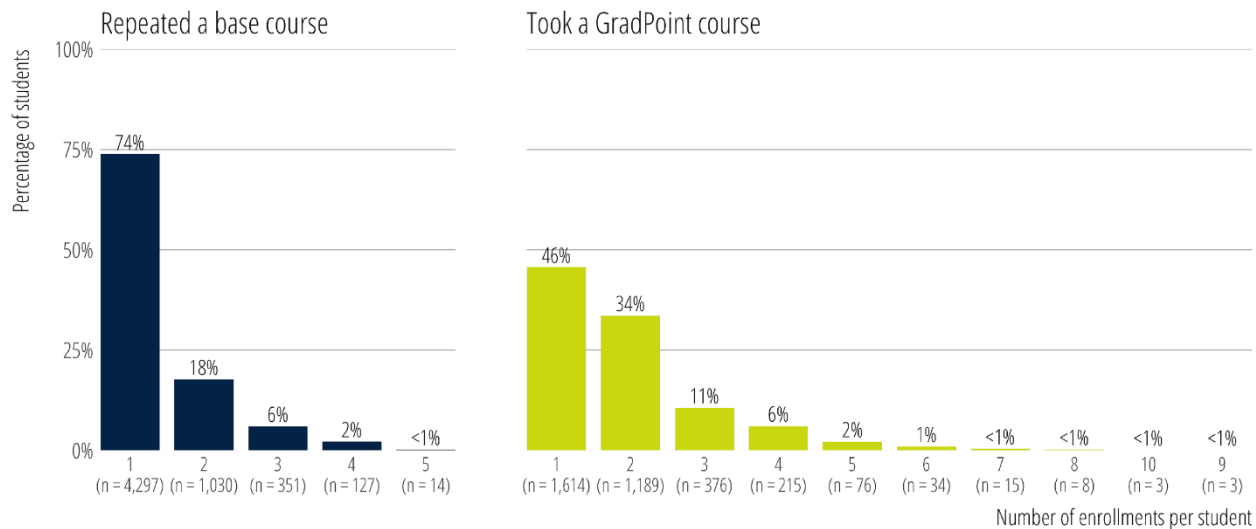
Note: Descriptive statistics are at the enrollment level. Students are counted multiple times if they were enrolled in multiple credit recovery courses during 2015-16.

Overview of GradPoint enrollments and original credit course repetitions

Enrollments per student

During the 2015-16 academic year, there were 65,964 unique students enrolled in one of 24 Connections Academy schools. Of these students, 10.5% (or 6,898 students) were enrolled in at least one repeated original credit course during that year, and 5.4% (or 3,533 students) were enrolled in at least one GradPoint course. Figure 1 shows the distribution of credit recovery enrollments by student. The vast majority of students who pursued credit recovery by repeating a failed course repeated only a single course during 2015-16 (74% of original credit course repeaters). By contrast, the majority of students who pursued credit recovery via GradPoint tended to take multiple GradPoint courses during 2015-16 (54% of GradPoint students took two or more GradPoint courses).

Figure 1: Number of course repetitions / GradPoint enrollments per student in 2015-16



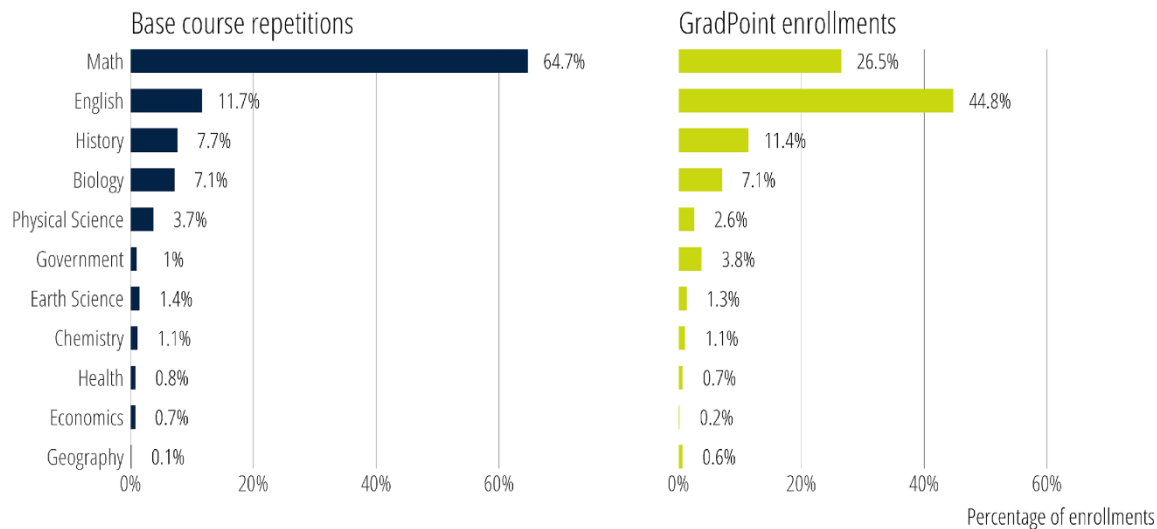
This enrollment pattern is one important motivation for the current impact evaluation study. If taking a GradPoint course is, as hypothesized, *more effective* than repeating a failed course, then enrolling in multiple GradPoint courses during a single academic year would be an expedient way for students to recover credits and get back on track towards graduation. If, however, contrary to expectation, taking a GradPoint course is *less effective* than repeating a failed course, then GradPoint students are at risk of falling further behind, particularly if they take multiple GradPoint courses in a single year.

Enrollments by subject area

Figure 2 shows the percentage breakdown by subject area of all GradPoint enrollments and repeated course enrollments that were complete at the time of this study (i.e., the full sample of credit recovery enrollments, prior to propensity score-matching). Two aspects of this overall enrollment pattern are worthy of note. First, the vast majority of credit recovery enrollments during 2015-16 were in English and Math. These two subject areas comprised a total of 76.3% of course repetitions and 71.2% of GradPoint enrollments.

Second, the relative proportion of Math to English enrollments differed starkly between GradPoint students and original credit course repeaters. For course repetitions, the lion's share of enrollments (64.7%) were in Math, with English enrollments taking a distant second (11.7%). For GradPoint, this enrollment pattern was reversed: English courses comprised the largest percentage of GradPoint enrollments (44.8%), with Math courses comprising a smaller, though still sizable, portion (26.5%) of enrollments.

Figure 2: Credit recovery enrollments by subject (full sample, prior to propensity score-matching)



This enrollment asymmetry has important consequences for how we assess the impact of taking a GradPoint course on learner outcomes. Course difficulty varies across subject areas, with Math being the hardest subject area overall, as measured by course fail rates, and English being somewhat easier (see Figure 1).

Because of this variability in difficulty, the different subject area enrollment patterns between GradPoint students and course repeaters during 2015-16 pose a risk for impact evaluation. Specifically, even if there is no benefit of taking a GradPoint course relative to repeating a course, we run the risk of observing a spurious GradPoint advantage simply because the available sample of GradPoint enrollments covered easier subject matter on average (i.e., fewer Math enrollments and more English enrollments).

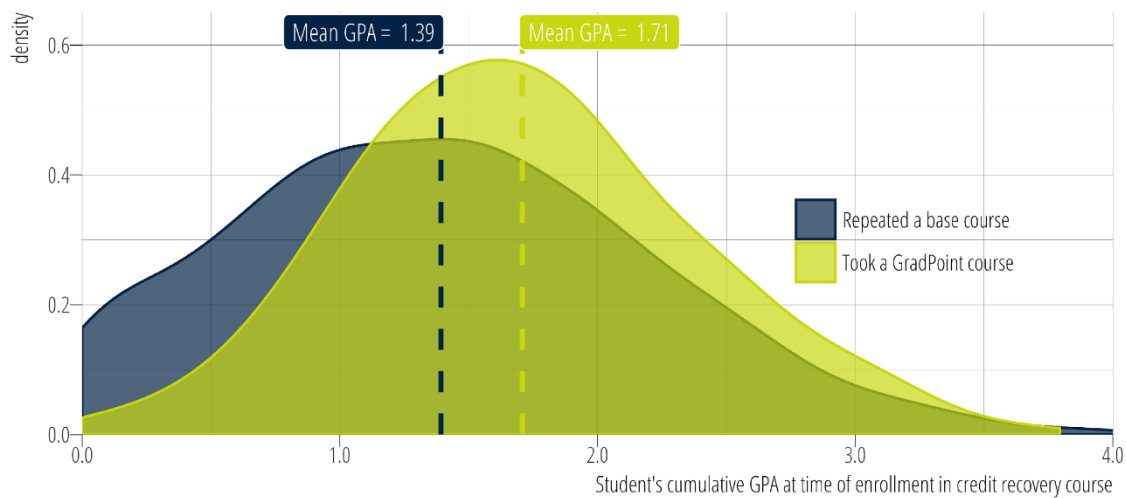
We return to this point in the next section. For now, it is sufficient to note that this risk – and the resulting need to establish *baseline equivalence* between the treatment (GradPoint) and comparison (course repetition) samples – motivated our analytic approach. We used both propensity score-matching and multi-level regression modeling to account for a range of factors, including course enrollments, that potentially introduce confounding achievement-related variability into the data.

Enrollments by student prior achievement

Figure 3 shows the distribution of credit recovery seekers in 2015-16 in terms of their cumulative GPA at the time they enrolled in a credit recovery course. In this sample of students, those who pursued credit recovery by taking a GradPoint course tended to have a higher GPA ($M = 1.71$, $SD = 0.68$) than students

who repeated a course ($M = 1.39$, $SD = 0.8$), a difference that was statistically significant ($\beta^{\wedge} = 0.32$, $t = 16.78$, $p < .001$).

Figure 3: Prior achievement of students pursuing credit recovery by repeating a course versus taking a GradPoint course (full sample, prior to propensity score-matching)



This difference in prior achievement is not necessarily surprising. It is likely due, at least in part, to the enrollment asymmetry discussed above. As noted in the preceding section, course repeaters were more likely than GradPoint students to be enrolled in a Math course, and Math is the hardest subject overall. To the extent that the course repeaters in the current sample were more likely than GradPoint students to have struggled in previous Math courses (e.g., all previous Math courses, not just the one for which credit recovery was currently being sought), it is expected that they will have a somewhat lower GPA on average.

For purposes of the current impact evaluation, this difference in prior achievement further underscores the importance of accounting for confounding sources of achievement-related variability between GradPoint students and course repeaters. We turn now to our propensity score analysis, which endeavored to do just that.

Baseline equivalence after propensity score-matching

The results in the previous section showed that the available sample of GradPoint students differed from course repeaters on multiple achievement-related dimensions. Because of these differences, before we can assess the relative impact on learner outcomes of taking a GradPoint course versus

repeating a course, we first needed to identify a group of course repetitions that were directly comparable to the sample of GradPoint enrollments.

We therefore conducted a nearest neighbor propensity score-matching analysis to identify a subsample of all course repetitions from 2015-16 that were as similar as possible to the sample of GradPoint enrollments across all nine achievement-related variables in the available data: (1) student's cumulative GPA at the time of enrolling in a credit recovery course; (2) gender; (3) race; (4) ELL status (whether the student was an English language learner or not); (5) IEP status (whether the student was on an individualized education plan during 2015-16, or not); (6) enrollment status (whether the student was a new or returning Connections Academy student); (7) enrollment time (whether the student enrolled on time or late); (8) the course for which credit recovery was sought, and (9) the Connections Academy school/location where the student was enrolled.

In the remainder of this section, we illustrate the extent to which this propensity score-matching analysis succeeded in establishing *baseline equivalence* between the treatment and control samples across these nine achievement-related variables.

Prior achievement

Before propensity score-matching, there was a prior achievement gap in the available sample of credit recovery seekers, with GradPoint students having a cumulative GPA that was 0.32 (i.e., $ES = 0.32 / 0.78 = 0.410$ SDs) points higher on average than course repeaters (see Figure 4). Propensity score-matching reduced this prior achievement gap. After the matching procedure, GradPoint students still had a significantly higher cumulative GPA than original credit course repeaters (see Table 4), but only by an average of 0.17 points ($M_{\text{Gradpoint course}} = 1.71$, $M_{\text{original credit course repetition}} = 1.54$).

This difference after matching (i.e., $ES = 0.17 / 0.78 = 0.218$ SDs) meets the What Works Clearinghouse (WWC) standards for baseline equivalence (WWC Standards Handbook Version 4.0, p14¹). That being said, the WWC does require the residual difference to be statistically adjusted for subsequent analyses that directly compare GradPoint students to course repeaters. Otherwise, GradPoint students might appear to have higher course pass rates, for example, simply because the comparison group of course repeaters identified via propensity score-matching was somewhat lower-achieving on average. We return to this point below when conducting the impact evaluations.

¹ *What Works Clearinghouse Standards Handbook Version 4.0* (October 2017). Retrieved from https://ies.ed.gov/ncee/wwc/Docs/referenceresources/wwc_standards_handbook_v4.pdf

Table 4: Summary of linear regression model predicting student prior achievement by credit recovery option

Variable	Estimate	Std. Error	z value	Pr(> z)
(Intercept)	1.54	0.01	102.68	< .001
Took a GradPoint course	0.17	0.02	7.9127	< .001

Student demographic characteristics

The sample of course repeaters identified by propensity score-matching was highly similar to the sample of GradPoint students in terms of student demographics. Tables 5, 6, and 7 show the results of logistic regression models assessing credit recovery enrollment (GradPoint = 1, original credit course repetition = 0) as a function of each of the three demographic variables that were included in the matching analysis: gender, status as an English language learner (ELL), and race. These models were specified with no intercept in order to compare each level of a demographic category to 0.5 (i.e., whether there was a 50/50 split between GradPoint enrollments and course repetitions for each demographic group).

The results in Table 5 show that students were equally likely to be enrolled in either credit recovery option, and this was true for both male and female students. Similarly, Table 6 shows that neither native English speakers nor English language learners were disproportionately enrolled in one credit recovery option over the other.

In terms of race, Black/African American students were more likely to be enrolled in course repetitions (see Table 7). White students were more likely to be enrolled in GradPoint courses, though only by a very small margin (i.e., a log-odds estimate of 0.12 translates to a proportion of 0.53, indicating that 53% of White students in the matched sample were enrolled in a GradPoint course, versus 47% in a original credit course repetition). Finally, Hispanic/Latino students were equally likely to be enrolled in either credit recovery option.

Table 5: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by gender

Variable	Estimate	Std. Error	z value	Pr(> z)
Female	0.03	0.04	0.73	0.47
Male	-0.04	0.04	-0.82	0.41

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

Table 6: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by ELL status

Variable	Estimate	Std. Error	z value	Pr(> z)
Native English speaker	0.00	0.03	0.07	0.94
English language learner	-0.18	0.27	-0.66	0.51

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

Table 7: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by race

Variable	Estimate	Std. Error	z value	Pr(> z)
Black/African American	-0.53	0.09	-6.12	< .001
Hispanic or Latino	-0.07	0.08	-0.91	0.36
Other	-0.09	0.10	-0.91	0.36
White	0.12	0.04	3.35	< .001

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

In summary, with the exception of Black/African American students, the matching procedure resulted in a close match between GradPoint students and course repeaters in terms of race, gender and ELL status. The WWC standards for baseline equivalence would, in the cases of these demographic characteristics, require that the estimates from Tables 5-7 be less than or equal to 0.4125 (WWC Procedures Handbook Version 4.0, p13). The difference in the percentage of African American students between the study groups is beyond this threshold. To meet the What Works Clearinghouse standards for baseline equivalence, the statistical model adjusted for the remaining differences after matching for all the student demographic characteristics (What Works Clearinghouse Standards Handbook Version 4.0, p14²).

Enrollment characteristics

The propensity score analysis further yielded a close match between GradPoint students and course repeaters in terms of student-level enrollment characteristics: the proportion of on-time and late enrollers in each group (Table 8), the proportion of new students versus returning students (Table 9),

² [1] What Works Clearinghouse Procedures Handbook Version 4.0 (October 2017). Retrieved from https://ies.ed.gov/ncee/wwc/Docs/referenceresources/wwc_procedures_handbook_v4.pdf

and the proportion of students who were not on an individualized education plan (IEP) during 2015-16 (Table 10). Students who *were* on an IEP, however, were more likely to be enrolled in a base course repetition (see Table 10). The WWC standards for baseline equivalence would, in the cases of the enrollment time, status, and IEP characteristics, require that the estimates from tables 8-10 be less than or equal to 0.4125 (WWC Procedures Handbook Version 4.0, p13). All estimates are within this threshold, though *students on an IEP* is statistically significant.

Table 8: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by enrollment time

Variable	Estimate	Std. Error	z value	Pr(> z)
Late enrollments	0.08	0.05	1.49	0.14
On-time enrollments	-0.04	0.03	-1.03	0.30

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

Table 9: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by student enrollment status

Variable	Estimate	Std. Error	z value	Pr(> z)
New students	0.01	0.04	0.29	0.78
Returning students	-0.01	0.04	-0.25	0.81

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

Table 10: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by whether students were on an Individualized Education Plan (IEP) during 2015-16 or not

Variable	Estimate	Std. Error	z value	Pr(> z)
Student on an IEP	-0.31	0.08	-3.91	< .001
Student not on an IEP	0.05	0.03	1.56	0.12

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

The matching procedure was less effective at establishing baseline equivalence between GradPoint students and course repeaters in terms of the actual course for which credit recovery was sought. Some courses – Biology, Health, Physics and History – were evenly distributed (i.e., approximately 50/50 split) between GradPoint enrollments and course repetitions (see Table 11). However, courses in English, Government and Geography had significantly more GradPoint enrollments than course repetitions, whereas courses in Math, Economics and Chemistry had more course repetitions than GradPoint enrollments. This pattern is shown clearly in Figure 4.

The inability of the matching procedure to yield a close match at the course level is not surprising. As discussed above, in the full sample, there was a large asymmetry between GradPoint enrollments and course repetitions (e.g., an over-representation of English courses among GradPoint students, and an over-representation of Math courses among course repeaters. See Figure 3). Propensity score-matching is specifically designed to overcome such imbalances. Doing so, however, requires a large number of potential control observations to select from. For the current study, the sample of course repetitions was simply too small to afford a close match at the course level given (a) the large number of courses and (b) the asymmetric credit recovery enrollments across courses, in combination with (c) the large number of other matching factors. Given the lack of baseline equivalence at the level of course enrollment, further steps are needed to control for course-level variability when assessing the relative impact on learner outcomes of taking a GradPoint course versus repeating a course. We return to this point in the next section.

Table 11: Logistic regression predicting course type (GradPoint = 1, course repetition = 0) by course

Variable	Estimate	Std. Error	z value	Pr(> z)
Algebra 1	-1.01	0.08	-11.88	< .001
Algebra 2	-0.68	0.09	-7.23	< .001
Biology	-0.14	0.11	-1.34	0.18
Chemistry	-0.50	0.25	-2.03	< .05
Earth Science	-0.42	0.22	-1.93	= 0.05
Economics	-1.03	0.52	-1.98	< .05
English I	0.82	0.11	7.55	< .001
English II	0.56	0.10	5.33	< .001
English III	1.89	0.15	12.61	< .001
English IV	0.56	0.11	4.94	< .001

Geography	1.25	0.57	2.21	< .05
Geometry	-0.35	0.07	-4.88	< .001
Government	1.44	0.24	5.95	< .001
Health - Fitness - and Nutrition	0.37	0.39	0.96	0.34
Physical Science Chemistry	-0.77	0.25	-3.13	< .01
Physical Science Physics	0.39	0.27	1.45	0.15
Pre-Algebra	-0.92	0.59	-1.55	0.12
US History	0.08	0.11	0.74	0.46
World History	-0.13	0.15	-0.85	0.40

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

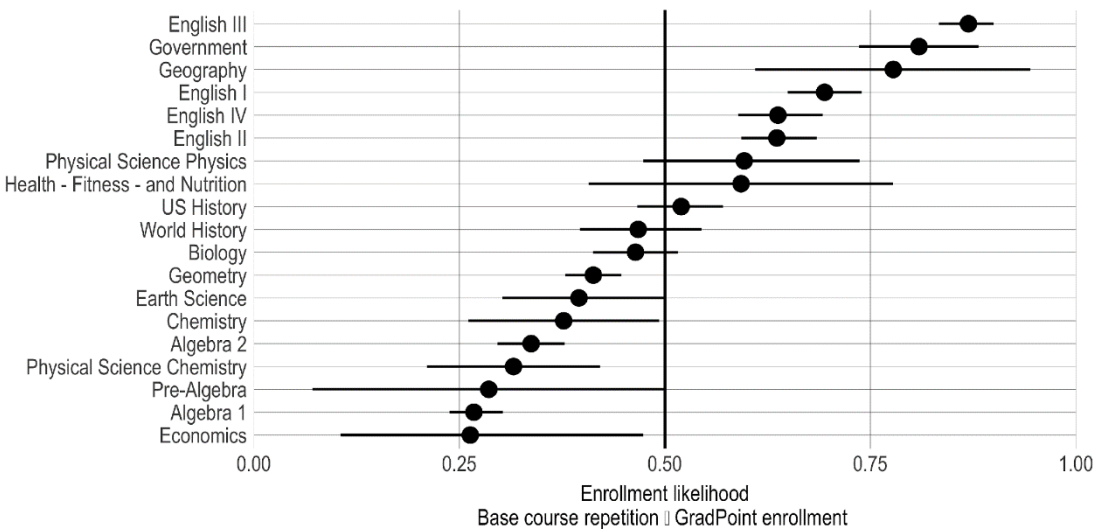


Figure 4: Proportion of GradPoint enrollments versus course repetitions for each course after propensity score-matching

The final variable included in the propensity score-matching analysis was the Connections Academy school where each student was enrolled. Some schools in the resulting matched sample – School 8, School 11, School 12, School 14 and School 17 – had a comparable number of students seeking credit recovery via GradPoint versus repeating a course (see Table 12). By and large, however, the matching procedure did not yield close alignment at the school level. As with the course enrollment findings above, this lack of close alignment is not surprising given the available sample size and the fact that the



matching algorithm was tasked with identifying, for each GradPoint student, a corresponding course repeater who was seeking credit recovery in the same course, and who had similar prior achievement, was similar on a range of demographic characteristics, *and* who was a student at the same school.

Table 12: Logistic regression predicting course type (GradPoint = 1, original credit course repetition = 0) by school/location

Variable	Estimate	Std. Error	z value	Pr(> z)
School 01	13.57	189.30	0.07	0.94
School 02	-0.75	0.43	-1.76	= 0.08
School 03	1.44	0.18	8.01	< .001
School 04	1.71	0.36	4.74	< .001
School 05	-0.90	0.36	-2.51	< .05
School 06	-1.10	0.67	-1.65	= 0.1
School 07	0.68	0.19	3.60	< .001
School 08	-0.47	0.57	-0.82	0.41
School 09	1.10	0.15	7.41	< .001
School 10	-0.82	0.14	-6.03	< .001
School 11	-0.23	0.26	-0.89	0.37
School 12	0.00	0.24	0.00	1.00
School 13	0.51	0.09	5.95	< .001
School 14	-0.10	0.19	-0.56	0.58
School 15	0.90	0.07	13.41	< .001
School 16	1.44	0.50	2.88	< .01
School 17	-0.41	0.91	-0.44	0.66
School 18	-0.79	0.21	-3.78	< .001
School 19	1.61	0.49	3.29	< .01
School 20	-0.82	0.15	-5.42	< .001
School 21	-0.49	0.08	-5.99	< .001
School 22	-1.32	0.15	-8.79	< .001
School 23	-1.01	0.19	-5.40	< .001
School 24	-1.28	0.10	-12.75	< .001

Note: Model contains no intercept. Hence, coefficient estimates indicate deviation from 0.5. Positive (negative) coefficients indicate higher (lower) representation among GradPoint students than among course repeaters.

Summary of propensity score-matching results

In summary, the nearest-neighbor propensity score-matching analysis identified a sample of course repetitions that were comparable to the treatment sample of GradPoint enrollments on multiple achievement-related dimensions.

These dimensions included student race, gender and status as an English language learner. Across the levels of the student demographics, only African American and White students showed a statistically significant asymmetry between the study groups, and only for the African American group was the difference beyond the 0.4125 threshold required by the What Works Clearinghouse for acceptable baseline equivalence.

For the enrollment matching dimensions, enrollment status and enrollment time had no statistically significant group differences. Though IEP status did have a statistically significant asymmetry with *students on an IEP*, this difference was within the 0.4125 threshold.

Further, the matching procedure reduced, though did not eliminate, asymmetries between the treatment and comparison groups in terms of course enrollment and school/location. Again, the WWC standards for baseline equivalence would require that the estimates from Tables 11 and 12 be less than or equal to 0.4125 (WWC Procedures Handbook Version 4.0, p13). Eleven of the 19 courses and 16 of the 24 schools had statistically significant asymmetries beyond the 0.4125 threshold.

Lastly, the study groups were adequately matched on *students' prior cumulative GPA* (i.e., prior achievement) according to What Works Clearinghouse standards for baseline equivalence (i.e. $ES < 0.25$ SDs).

The WWC procedures would require the residual differences after matching to be statistically adjusted for subsequent analyses that directly compare GradPoint students to course repeaters. To this end, a multi-level regression analysis was used that adjusted for remaining residual differences in matching factors that remained between the treatment and comparison groups after propensity score-matching. The data analysis procedure is explained in a later section.

Impact of taking a GradPoint course on pass rates

We turn now to our primary goal of assessing whether taking a GradPoint credit recovery course leads to better learner outcomes than repeating a failed course.

We begin by assessing learner outcomes at the level of course pass rates: that is, whether students who took a GradPoint course were more likely than students who repeated a course to earn a passing grade and thereby recover lost credits. To do this, we fit a multilevel logistic regression model to the pass/fail data (pass = 1, fail = 0) with credit recovery option (GradPoint versus course repetition) as the critical

predictor. Since the propensity score-matching procedure resulted in closely matched, but not fully matched, treatment and comparison groups, we also included the achievement-related matching variables as covariates in the analysis to statistically adjust for residual differences along these dimensions.

Specifically, the following seven variables were included as fixed effect covariates: student gender, race, ELL status, enrollment status, enrollment time, IEP status and students' cumulative GPA at the time of enrolling in the credit recovery course. We also included a random intercept for course and a random intercept for school to account for variability in course pass rates across courses and schools (as shown above, some courses are consistently harder than others – notably Math courses – and the minimum pass score varies across schools. This suggests that some schools are 'harder' than others. Finally, we specified a by-course and by-school random slope for credit recovery option to assess whether the relative effect of taking a GradPoint course varied across courses and schools.

The final model may best be categorized as a two level model with students' information entered at the first level. In addition there are two parallel higher levels for course and Connections schools each with random intercepts and random slopes for the treatment status.

All covariates were centered: numeric centering for continuous variables (GPA), and sum contrast coding (i.e., effect coding) for categorical variables. The treatment variable was dummy-coded (GradPoint course = 1, course repetition = 0). Given this coding scheme, the model intercept indicates the pass rate for an average student who repeated a course (i.e., a course repeater with average values for all covariates). The coefficient estimate for the treatment variable indicates the average effect of taking a GradPoint course (relative to repeating a course) when holding all covariates at the mean.

The results of this multilevel logistic regression analysis are summarized in Table 13. We unpack each of the significant results in turn.

Table 13: Summary of Hierarchical Generalized Linear Model analysis of course pass rates in the propensity score-matched sample

	Variable	Odds Ratio	95% CI	Pr(> z)
Fixed				
	(Intercept)	0.83	0.5--1.4	0.50
	Took a GradPoint course	6.98	3.5--13.9	< .001
	Cumulative GPA (previous semester)	3.10	2.7--3.6	< .001
	Enrollment status (= new student)	0.65	0.5--0.8	< .001

	Enrollment time (= late enroller)	0.83	0.6--1.1	0.14
	Gender (= F)	0.95	0.8--1.1	0.47
	Race (= White)	0.91	0.7--1.2	0.44
	Race (= Black/African American)	1.29	0.9--1.9	0.17
	Race (= Hispanic or Latino)	1.10	0.8--1.5	0.59
	English language learner (= no)	0.88	0.4--1.8	0.71
	IEP status (= on individual education plan)	1.07	0.9--1.3	0.57
	Took a GradPoint course: cumulative GPA	1.17	0.9--1.5	0.23
	Took a GradPoint course: new student	1.54	1.1--2.2	< .05
	Took a GradPoint course: late enroller	0.75	0.5--1.1	0.13
Random				
	Variable	Variance	Std.Dev.	Corr
Location	(Intercept)	0.17	0.42	
	Took a GradPoint course	1.36	1.17	0.03
Course	(Intercept)	0.33	0.58	
	Took a GradPoint course	0.16	0.4	-0.39

Note: Analytic sample, $n = 4,603$. Location, $N = 17$. Course, $N = 15$. ICC for Location = 0.05. ICC for Course = 0.09. Variance Inflation Factor (VIF) for fixed effects, range: 1.01--2.55.

Note: In order to reliably estimate the relative effect of taking a GradPoint course across schools (i.e., by-location random slope), we excluded schools with fewer than 25 observations in either the treatment (GradPoint) or comparison (course repetition) group. Likewise, to estimate the by-course random effect of GradPoint, we excluded courses with fewer than 25 observations (across schools) in either group. These criteria resulted in the exclusion of seven Locations (schools) and four courses, for a total exclusion of 273 observations from the full propensity score-matched sample ($n = 4,876$).

Note: All covariates were centered: numeric centering for continuous variables (GPA), and sum contrast coding (i.e., effect coding) for categorical variables. Thus, the treatment coefficient indicates the average effect of taking a GradPoint course, relative to repeating a course, when holding all covariates at the mean. See the text for further explanation.

Overall effect of GradPoint

Adjusted course pass rates were 40 percentage points higher, on average, for GradPoint enrollments – or nearly twice as high – compared to a matched sample of original credit course

repetitions. Specifically, after adjusting for achievement-related student characteristics and enrollment factors, the average adjusted pass rate for GradPoint enrollments was 85%, compared to an average pass rate of 45% for course repetitions (see Figure 5).

Figure 5: Marginal effect of credit recovery type on course pass rates. Error bars denote 95% prediction intervals

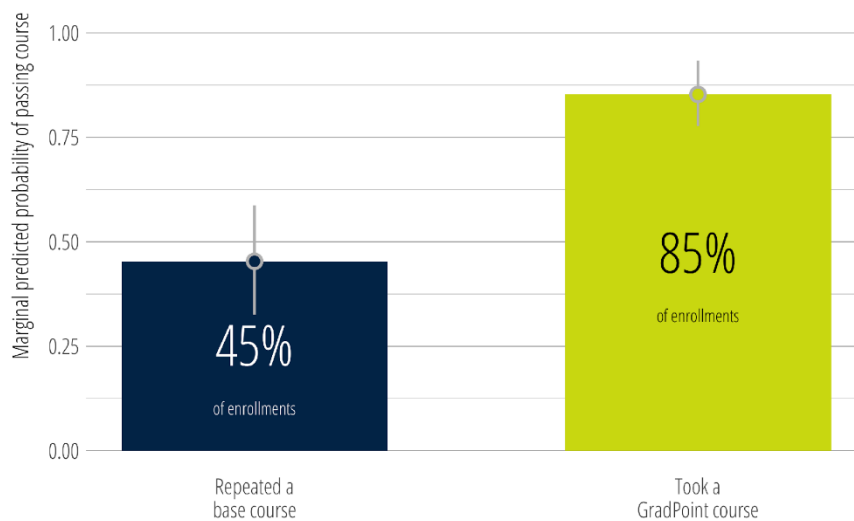


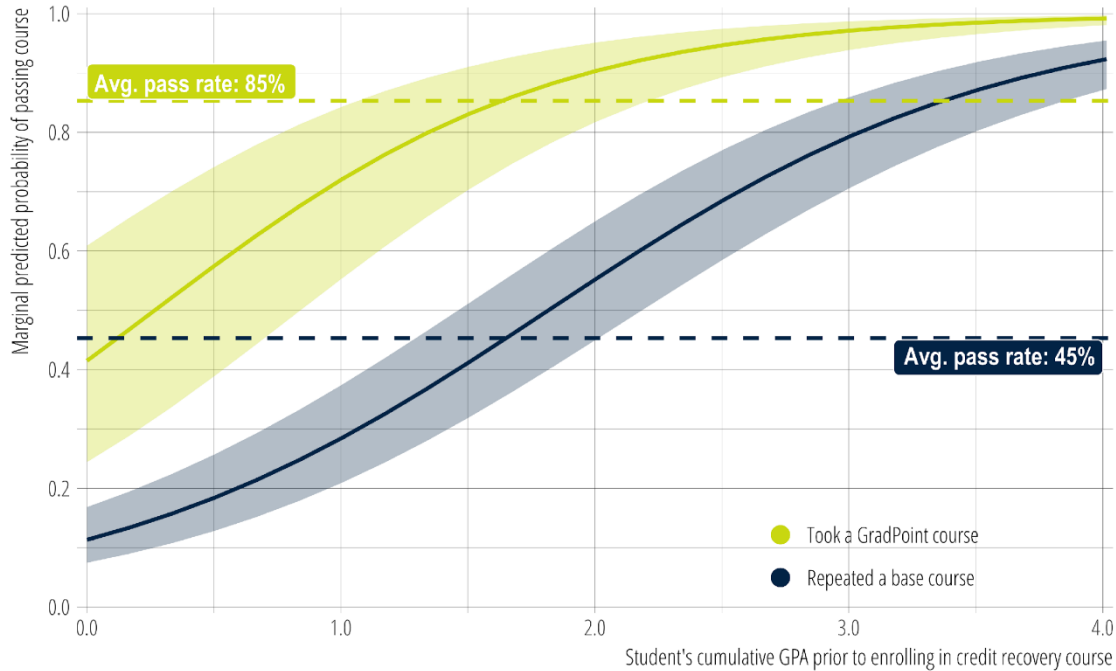
Figure 6 gives a more nuanced view of the GradPoint advantage by showing the adjusted probability of students passing a credit recovery course based on their cumulative GPA at the time of enrollment. Several aspects of this graph are worthy of note. First, and most obviously, pass rates increased for both GradPoint courses and course repetitions as the student's prior GPA increased (i.e., the significant main effect of GPA reported in Table 13), with a comparable rate increase for both course types (i.e., the lack of a significant interaction between students' GPA and students' choice of credit recovery option in Table 13). In other words, higher-achieving students were, unsurprisingly, more likely to earn a passing grade.

Second, while the *average* pass rate for GradPoint courses was 85%, the adjusted pass rate for course repetitions only reached that level among course repeaters with a prior GPA of 3.4 or higher (see Figure 6, and note where the solid blue line intersects the dashed yellow line). That is, in terms of course pass rates, the *average* GradPoint student, who had a GPA of ~1.7, outperformed course repeaters with considerably higher prior achievement.

Third, while the average pass rate for course repetitions was 45%, nearly *all* GradPoint enrollments had an adjusted pass rate higher than that. In particular, historically lower-achieving students with a GPA of

~1.0 who sought credit recovery via GradPoint had an adjusted course pass rate of ~71%, with pass rates increasing to 90% or higher among GradPoint students with at least a 2.0 GPA (see Figure 6).

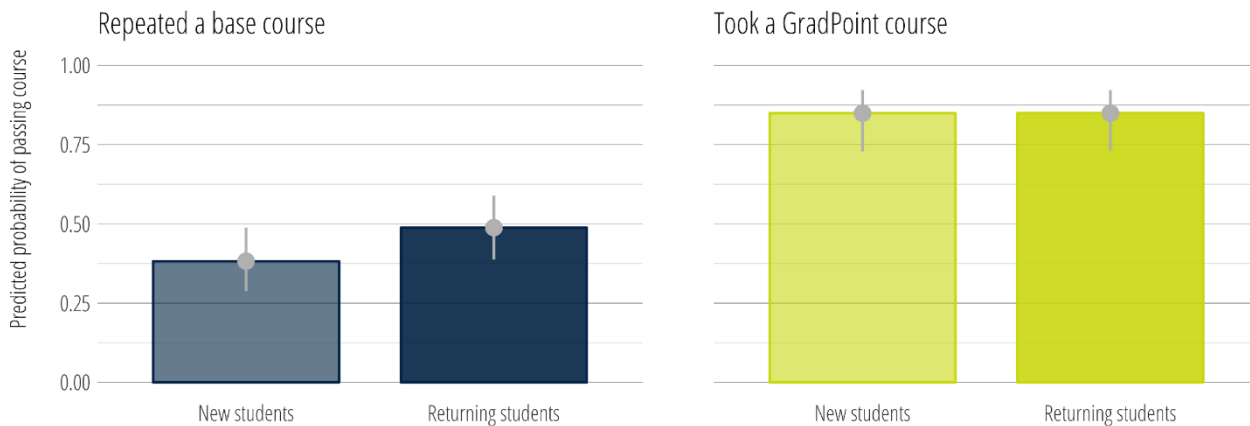
Figure 6: Adjusted course pass rates by course type and students' cumulative GPA. Ribbons denote 95% prediction intervals



Differences between new and returning Connections Academy students

Not only did taking a GradPoint course lead to higher pass rates overall, GradPoint courses also reduced a discrepancy between new versus returning Connections Academy students, as indicated by the significant interaction between enrollment status (new versus returning Connections student) and credit recovery option (GradPoint versus course repetition) reported in Table 13. Specifically, as shown in Figure 7, pass rates for course repetitions were significantly lower among new Connections Academy students (average pass rate of 38%) than among returning Connections Academy students (average pass rate of 49%). By contrast, there was no significant difference between new and returning Connections Academy students who sought credit recovery through GradPoint: both student groups had a pass rate of 85% in their GradPoint credit recovery courses.

Figure 7: Course pass rates for new and returning Connections Academy students



Variability in the GradPoint advantage across courses and schools

The analyses presented so far have established a robust effect of taking a GradPoint course on credit recovery, relative to repeating an original credit course, which addresses the primary goal of this study. Evidence for this ‘GradPoint advantage’ comes from the *fixed effect* predictor estimates from the multi-level regression model described above (see Table 13).

One of the additional questions that motivated this study was whether the size of the GradPoint advantage varied across Connections Academy schools and across courses. To address this question, we examined the *random effects* from the multi-level regression model. Recall that random intercepts were specified for both school and course, with by-school and by-course random slopes for whether students took a GradPoint course or repeated a course.

Figure 8 shows the by-school random effects estimates. Color in this figure denotes the direction and magnitude of the difference between school-specific pass rate estimates and the average pass rate across schools, with (significantly) higher than average pass rates shown in (dark) blue and (significantly) lower than average rates shown in (dark) pink. The left-hand panel of Figure 8 illustrates that pass rates for course repetitions varied across schools, with schools 21, 22 and 24 having lower than average pass rates, and schools 1 and 2 having higher than average pass rates.

This variability is due, at least in part, to the fact that schools have different criteria for determining pass or fail. For most Connections Academy schools, the minimum passing score is 60. However, several schools, including schools 22 and 24, use a more conservative criterion of 70, which contributes to these schools having lower pass rates on average. Of course, there are also likely additional school-specific factors that contribute to variation in pass rates.

The right-hand panel of Figure 8 shows the relative size of the GradPoint advantage by school. The size of the GradPoint advantage was considerably larger than average at schools 10 and 14, and considerably lower than average at schools 9, 20 22, 23 and 24.

Figure 8: Random effects estimates by school

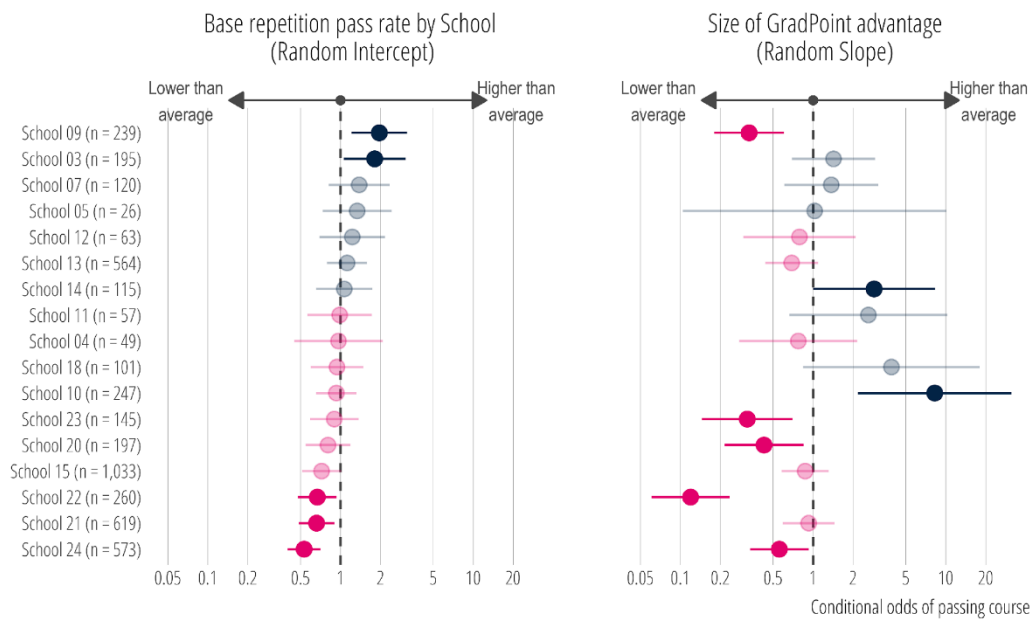
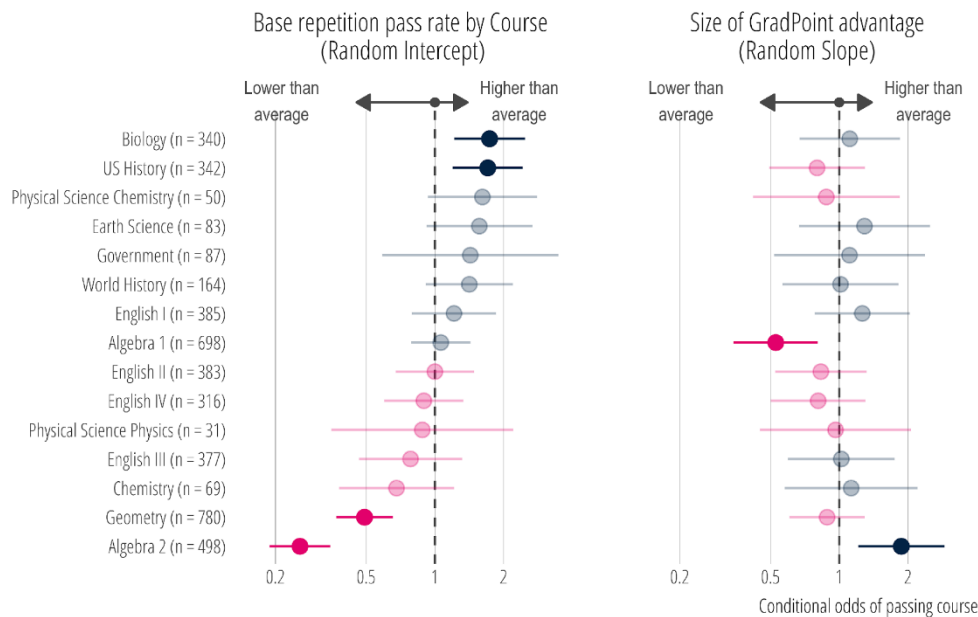


Figure 9 shows variability in the size of the GradPoint advantage across courses. Note that, as expected, course repetitions in Math tended to have lower than average pass rates, with Algebra 2 being the hardest (i.e., most frequently failed) course overall. Interestingly, the size of the GradPoint advantage was largest for Algebra 2 (see the right-hand panel of Figure 9). That is, students pursuing credit recovery for Algebra 2 benefitted the most from taking a GradPoint course, relative to repeating the original course.

Figure 9: Random effects estimates by course



In summary, the analyses presented in this section identified variability in the size of the GradPoint advantage across schools and courses. To understand *why* this variability exists – that is, to understand what causes GradPoint to be more or less effective for certain schools or courses – we would need to collect and analyze a wide range of contextual data about how GradPoint courses were implemented in the curricula across schools, the types of supports available to students at each school, and so on. Such data was not available for this study. Understanding the combination of contextual and/or implementation-level factors that maximize the GradPoint advantage is, therefore, a topic for further investigation. We return to this point in the Discussion section, where we outline directions for future research.

Exploratory analyses

Relationship between credit recovery option and number of credits recovered

The analysis so far has focused on course pass rates – and hence credit recovery – at the level of individual course enrollments. That is, we analyzed the difference in pass rates after matching each GradPoint enrollment to a course repetition that was as similar as possible in terms of the identity of the course (e.g., Algebra II, Biology, etc.), the Connections Academy school at which the enrollment occurred, and the demographic and academic characteristics of the student enrolled.

Our next step was to understand the pattern of credit recovery at the student level. Figure 10 shows the number of recovery credits attempted per student during 2015-16 versus the number of recovery credits earned, based on all students in the propensity score-matched sample. Note that this is an exploratory analysis, as GradPoint students and course repeaters were not matched on the number of recovery credits attempted. This was because including this variable in the matching analysis resulted in poor matching.

The first thing to notice in Figure 10 is the central tendency. Among students who sought credit recovery by repeating a course during 2015-16, the most common pattern was to enroll in a single credit recovery course (worth 0.5 credits) and to recover 0 credits (i.e., to fail the course), as denoted by the red dot. By contrast, among students who sought credit recovery by taking a GradPoint course, the most common pattern was to recover 0.5 credits after enrolling in a single credit recovery course.

A second pattern to notice is that this student-level analysis yields similar results to the enrollment-level analysis. The enrollment-level analysis above (see Figure 5) showed that 85% of GradPoint enrollments resulted in a passing grade, compared to only 45% of course repetitions. Indeed, looking at the student-level view presented in Figure 10, we see that GradPoint students tended to recover ~80% of the recovery credits they attempted (e.g., a GradPoint student who attempted to recover 2.5 credits during 2015-16 recovered 2 credits on average). Likewise, course repeaters tended to recover less than half the credits they attempted (e.g., a course repeater who attempted to recover 2.5 credits during 2015-16 only recovered 1 credit on average).

Figure 10: Number of recovery credits attempted versus credits earned per student during 2015-16, based on the students in the propensity score-matched sample

Recovery credits attempted vs. earned

Red dot denotes the median number of recovery credits attempted and earned per group. Note that credits are incremented by 0.5 because a semester-long course is worth 0.5 credits.

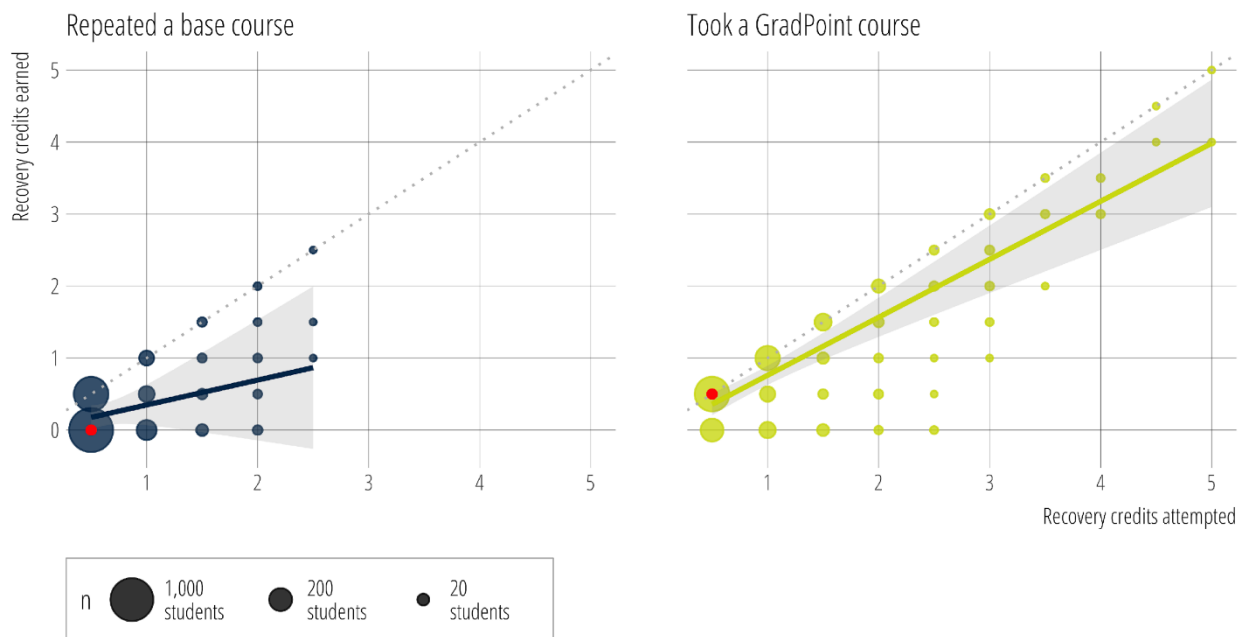
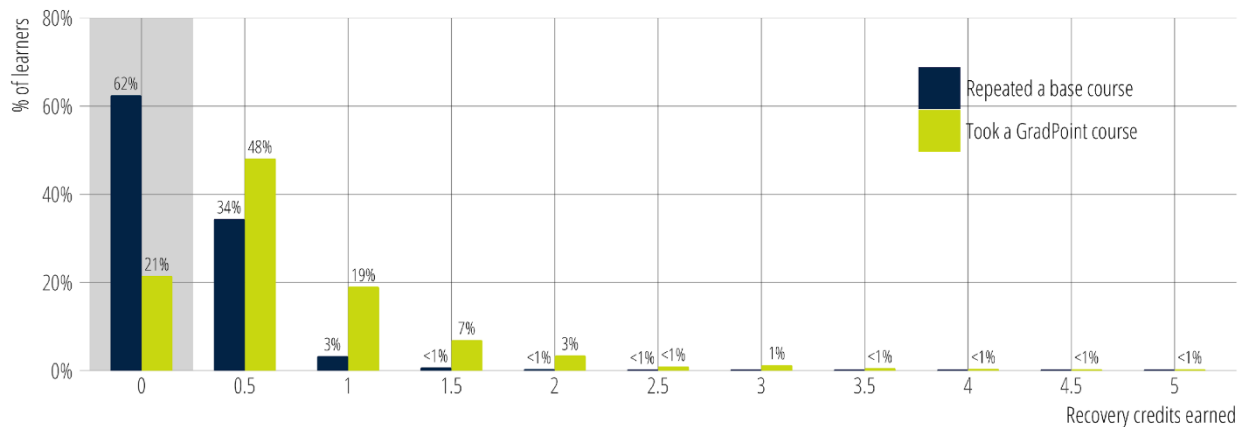


Figure 11 provides a further view of the number of credits recovered per student. Note that 31% of GradPoint students recovered 1 or more credits (i.e., passed two or more credit recovery courses) during 2015-16, compared to only 4% of course repeaters.

Figure 11: Distribution of recovery credits earned among students in the propensity score-matched sample

Distribution of recovery credits earned

The shaded grey region highlights the subset of students who failed all of the credit recovery courses they enrolled in and hence recovered 0 credits during 2015-16.



Impact of taking a GradPoint course on subject area knowledge

The analyses so far have focused on course pass rates and credit recovery patterns. Course pass rates are certainly an important component of student achievement. Another important dimension is the students' knowledge of course content (i.e., student learning). It is possible that GradPoint courses are simply easier than their corresponding original credit course equivalents, in which case GradPoint students might be more likely to earn a passing grade but learn less overall. This scenario is, of course, undesirable. Thus, we endeavored to assess the impact of taking a GradPoint course on student learning.

As well as higher pass rates, GradPoint students also tended to have similar subject knowledge, measured by their subsequent performance on English and Math state tests. After controlling for prior GPA, subject area, and course level, there was no statistically significant difference between those students who passed GradPoint and those who passed the repeated standard course in English or Math.

For this analysis, standardized state test scores were used as a measure of students' understanding of subject area content. Specifically, we compared state test scores in Math and English among the subset of students who passed a Math or English credit recovery course during the 2015-16 academic year and who also completed state testing in Math and English during that year (n = 296; 159 GradPoint students, and 137 course repeaters).

On average, these students performed at the 'basic proficiency' performance level (using a scale of below basic, basic, proficient, and advanced) on their state tests, though there were students with performance from all levels. In addition, these GradPoint students and the course repeaters were comparable in terms of their prior achievement, as measured by previous semester's cumulative GPA (an average cumulative GPA of 1.78 and 1.83, respectively).

Table 14 Summary of GLM analysis of Student State Test Performance.

Group	N	Mean GPA	Std. Deviation
Passed a GradPoint Course	159	1.78	0.657
Passed a Repeated Failed Course	137	1.83	0.800

Group	English/Math
Passed a GradPoint Course	71% / 29%
Passed a Repeated Failed Course	13% / 87%

Category	Passed GradPoint Course	Passed Failed Course
Below Basic Proficiency	19.5%	35%
Basic Proficiency	23.9%	35%
Proficient--Borderline	6.9%	8%

Proficient 41.5% 16.1%

Advanced 8.2% 5.8%

Listwise Deletion Sample						95% Confidence Interval	
	Parameter	B	Std. Error*	P- Value*	df	Wald Chi Square	Lower* Upper*
Threshold 1		0.531	0.4244	0.211	1	1.564	-0.301 1.363
Threshold 2		1.631	0.4524	0.000	1	13.000	0.744 2.518
Threshold 3		1.863	0.4726	0.000	1	15.541	0.937 2.789
Threshold 4		3.458	0.3994	0.000	1	74.968	2.675 4.241
Passed a GradPoint Course		0.221	0.3647	0.544	1	0.369	-0.936 0.493
Passed a Repeated Course		0					
Prior Cumulative GPA		0.477	0.1448	0.001	1	10.864	0.194 0.761
Subject = English		1.874	0.3567	0.000	1	27.606	1.175 2.573
Subject = Math		0					
Course Level = 1		-0.501	0.3584	0.162	1	1.953	-1.203 0.202

Course Level = 2 -0.114 0.2407 0.635 1 0.225 -0.586 0.358

Course Level = 3 -0.038 0.4198 0.928 1 0.008 -0.861 0.785

Course Level = 4 0

Subject by Course Level 0.391 3 3.004

(Scale) 1.000

Pooled 100 Imputed Samples 95% Confidence Interval

Parameter	B	Std. Error*	P-Value*	Fraction Missing Info	Relative Increase Variance	Relative Efficiency	Lower*	Upper*
Threshold 1	0.462	0.373 9	0.217	0.213	0.270	0.998	-0.271	1.195
Threshold 2	1.345	0.401 1	0.001	0.210	0.265	0.998	0.559	2.132
Threshold 3	1.576	0.428 6	0.000	0.191	0.235	0.998	0.736	2.416
Threshold 4	2.872	0.342 2	0.000	0.352	0.539	0.996	2.201	3.544
Passed a GradPoint Course	0.124	0.333 2	0.710	0.005	0.005	1.000	-0.777	0.529
Passed a Repeated Course	0							

Prior Cumulative GPA	0.394	0.123 6	0.002	0.401	0.665	0.996	0.151	0.636
Subject = English	1.162	0.220 3	0.000	0.275	0.377	0.997	0.730	1.594
Subject = Math	0							
Course Level = 1	- 0.042	0.345 7	0.902	0.149	0.175	0.999	-0.720	0.635
Course Level = 2	0.352	0.269 6	0.192	0.053	0.055	0.999	-0.177	0.880
Course Level = 3	- 0.182	0.298 0	0.541	0.017	0.017	1.000	-0.766	0.402
Course Level = 4	0							
Subject = English by Course Level = 1	- 0.142	0.466 8	0.762	0.124	0.141	0.999	-1.057	0.773
Subject = English by Course Level = 2	- 0.563	0.357 7	0.115	0.139	0.161	0.999	-1.265	0.138
Subject = English by Course Level = 3	0.102	0.368 0	0.781	0.099	0.109	0.999	-0.619	0.823
(Scale)	1.000							

**Note: A linear fixed effects model was employed along with a naïve covariance structure within a robust empirical standard error formulation (i.e., sandwich estimator with the traditional model-based estimator as the 'bread' in the sandwich). This procedure results in estimates that are unbiased and statistical hypothesis tests that are consistent despite the complex nested nature of the data*

Is the GradPoint advantage in Math mediated by enrollment in Math supplements?

The analyses presented thus far have sought to isolate the impact of taking a GradPoint course on learner outcomes by controlling and statistically adjusting for a wide range of achievement-related factors, including students' prior achievement, demographic characteristics and enrollment characteristics. One set of factors that was not globally controlled for in these analyses concerned students' behaviors during the course. Such behavioral data was largely unavailable. It is in principle possible, however, that students who took a GradPoint course were more (or less) likely than course repeaters to exhibit certain behaviors that contributed to their higher overall pass rates, such as engaging in academic tutoring services as part of their credit recovery plan, or completing all course assignments on time.

Because student-level behavioral data was largely unavailable, systematically accounting for the influence of student behavior on learner outcomes in credit recovery courses remains a topic for future research. We are, however, able to provide tentative insights on this topic for students specifically seeking credit recovery in Math. For these students, behavioral data was available concerning participation in supplemental Math programs (e.g., online tutoring services like MathXL). We therefore conducted an exploratory analysis to assess whether the effect of taking a GradPoint Math course versus repeating a Math course was mediated by participation in additional Math supplements.

Figure 12 shows the observed pass rates for all Math courses in the propensity score-matched sample, plotted by credit recovery option (course repetition versus GradPoint course) and whether the student additionally participated in Math supplements (either MathXL or Think Through Math) while seeking credit recovery. Note that of the 2,029 Math courses in this sample, only a very small number of GradPoint enrollments ($n = 37$) and course repetitions ($n = 17$) were from students who also participated in supplemental Math programs. Further, looking at credit recovery seekers who *did not* participate in supplemental math programs, pass rates for those enrolled in GradPoint courses were more than twice those of students enrolled in a course repetition (63% versus 29%). Thus, this data provides no evidence that the GradPoint advantage in Math can be attributed to participation in external Math supplement programs. In other words, this exploratory follow-up analysis provides further evidence about the overall effectiveness of GradPoint courses.

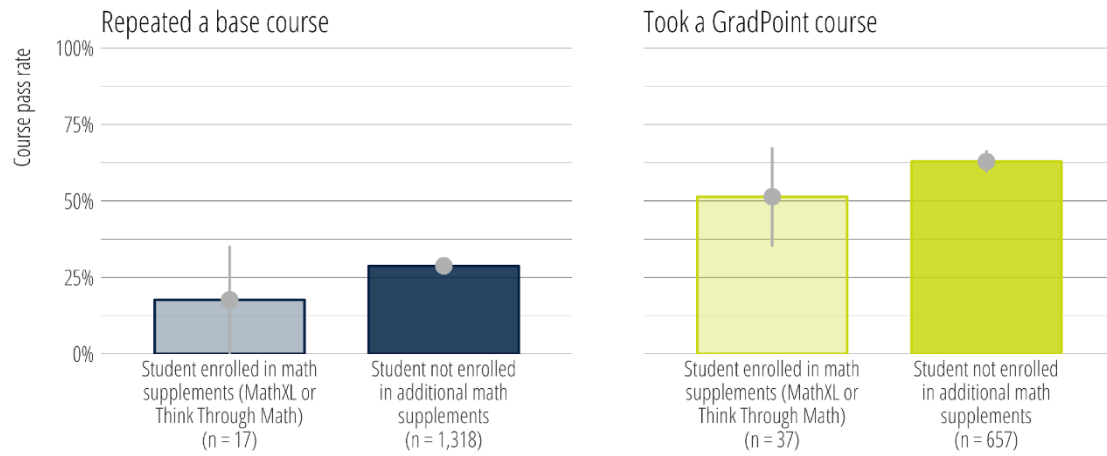


Figure 12: Math course pass rates by credit recovery option (course repetition versus GradPoint course) and student participation in Math supplements

Discussion

Efficacy statements

Course pass rates – comparative conclusions based on quasi-experimental design

- **Connections Academy schools offer successful solutions for struggling students to recover credits as evidenced by the high success rate of 85% for GradPoint courses.** The adjusted overall pass rate for students enrolled in a GradPoint credit recovery course was 85%, compared to only 45% for students enrolled in a course repetition.
- **Adjusted course pass rates were 40% higher, on average, for GradPoint enrollments compared to a matched sample of course repetitions.** Connections Academy students taking GradPoint credit recovery online courses, after failing a course, were almost twice as likely to pass the course than similar students (matched on prior GPA and after adjusting for demographic and enrollment factors) who repeated with a Connections Academy standard course.
- While the overall adjusted pass rate for a typical student enrolled in a GradPoint course was 85%, the adjusted pass rate for course repetitions only reached that level among course repeaters with a prior GPA of 3.4 or higher (see Figure 6).
- While the adjusted pass rate for a typical student enrolled in a course repetition was 45%, nearly all GradPoint students had a predicted pass rate at or above that level. In particular, historically lower-achieving students with a GPA of ~1.0 who sought credit recovery via GradPoint had an adjusted course pass rate of ~71%, with pass rates increasing to 90% or higher among GradPoint students with at least a 2.0 GPA (see Figure 6).
- As shown in Figure 7, pass rates for course repetitions were significantly lower among new Connections Academy students (average pass rate of 38%) than among returning Connections Academy students (average pass rate of 49%). By contrast, there was no significant difference between new and returning Connections Academy students who sought credit recovery through GradPoint: both student groups had a pass rate of 85% in their GradPoint credit recovery courses.

Students' subject knowledge – relational conclusions

We conducted an *exploratory analysis* of the impact of GradPoint on students' subject knowledge of area content. Included in this analysis were the 296 students (159 GradPoint students and 137 course repeaters) who sought and passed credit recovery courses in Math and English during 2015-16 *and* who also completed state testing in Math and English during that year. On average, these students

performed at the 'basic proficiency' performance level (Using a scale of below basic, basic, proficient, and advanced) on their State Tests.

As well as higher pass rates, GradPoint students also tended to have similar subject knowledge as measured by their subsequent performance in English and Math state tests. After controlling for prior GPA, subject area and course level, students who passed GradPoint credit recovery online courses tended to perform as well as students who passed the repeated standard course in Math and English state assessments, as there was no statistically significant difference in performance.

Limitations

The propensity score-matching procedure used to establish baseline equivalence between the treatment (GradPoint) and comparison (course repetition) groups yielded a closely matched, though not perfectly matched, sample.

After propensity score-matching, the treatment and comparison groups were comparable across a wide range of achievement-related dimensions, though some differences remained between these groups in terms of course enrollment patterns and percent African American. Given the large number of matching variables, combined with the relatively small sample of credit recovery data (i.e., only one year of credit recovery enrollments was available, since 2015-16 was the first year of Connections GradPoint), some degree of residual difference between the treatment and comparison groups was anticipated.

Note, however, that we statistically adjusted for these residual differences in all analyses that directly compared GradPoint students to course repeaters by including the matching variables as covariates. It should also be noted that students' cumulative GPA was successfully matched according to the WWC standards for baseline equivalence.

Directions for future research

- An important step for future research is to conduct a rigorous assessment of the impact of taking a GradPoint course on students' knowledge of subject area content. For the current study, we were only able to conduct a preliminary and exploratory assessment. While the preliminary results were suggestive, it is unclear whether these results are robust (due to a limited sample size) and whether these findings generalize to subject areas other than Math and English. Further research is needed to understand the impact of GradPoint on student learning across the range of credit recovery course offerings.
- One interesting finding from this study was that the size of the GradPoint advantage varied considerably across schools and to a lesser extent across courses. Given the current data, we were able to identify schools and courses that showed a larger or smaller GradPoint advantage

than average. However, we were not able to assess the cause. An important direction for future research is to investigate the combination of contextual, implementation-level and/or school-specific factors that affect the size of the GradPoint advantage across schools and courses. This would aid in understanding the conditions that maximize learner outcomes when taking a GradPoint course.

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