

**Efficacy of Online Algebra I for Credit Recovery for At-Risk Ninth Graders:
Consistency of Results from Two Cohorts**

Authors and Affiliations:

Jessica Heppen (AIR), Nicholas Sorensen (AIR), Elaine Allensworth (CCSR), Kirk Walters (AIR), Suzanne Stachel (AIR), Valerie Michelman (CCSR)

American Institutes for Research (AIR)
Consortium on Chicago School Research (CCSR)

Background / Context:

The consequences of failing core academic courses during the first year of high school are dire. In the Chicago Public Schools (CPS), only about one-fifth of off-track freshmen—students who fail more than one semester of a core academic course and/or fail to earn enough credits to be promoted to 10th grade—graduate high school, compared with over 80% of on-track freshmen (Allensworth & Easton, 2005, 2007). Failure of Algebra I is particularly problematic. In CPS, only 13% of students who fail both semesters of Algebra I in 9th grade graduate in 4 years, and the largest share of 9th grade algebra failures occur in the second semester of the course. Elucidating the ways that students can get back on track is of the utmost policy importance.

Credit recovery is one strategy to deal with high failure rates. The primary goal of credit recovery programs is to give students an opportunity to retake classes that they failed in an effort to get them back on track and keep them in school (Watson & Gemin, 2008). As schools across the nation struggle to keep students on track and re-engage students who are off track, online learning has emerged as a promising and increasingly popular strategy for credit recovery: more than half of respondents from a national survey of administrators from 2,500 school districts reported using online learning in their schools for credit recovery, with just over a fifth (22%) reporting “wide use” of online learning for this purpose (Greaves & Hayes, 2008).

Despite the growing use of online courses for credit recovery, the evidence base is thin. This paper describes the design, implementation, and results of a randomized control trial that was designed to address this gap. The primary intent of the proposed paper is to share findings to date for the two cohorts of students who participated in credit recovery as part of this trial – first time freshmen in 2010-11 and first-time freshmen in 2011-12.

Purpose / Objective / Research Question / Focus of Study:

This study is an efficacy trial funded by a grant from the Institute of Education Sciences (IES) National Center for Education Research (NCER). Participating schools were 15 CPS high schools in 2011 and 13 CPS high schools in 2012. In these schools, grant funds supported the implementation of at least two Algebra I credit recovery courses during the summer sessions of 2011 and 2012—one online and one face-to-face (f2f). These courses allow students to recover a ½ credit of Algebra I. The study is designed to address a set of research questions that gauge the efficacy of online Algebra I for credit recovery, compared with standard f2f Algebra I for credit recovery. The study is also designed to determine the supporting classroom conditions under which students may or may not be successful in credit recovery, and to gauge the extent to which credit recovery can help at-risk students get back on track, relative to students who passed Algebra I in 9th grade.

This paper focuses on the impact of taking online Algebra I for credit recovery for two cohorts. Cohort 1 includes first-time freshmen in 2010-11 who failed Algebra I in ninth grade and enrolled in summer credit recovery in summer 2011. Cohort 2 includes first-time freshmen in 2011-12 who failed the course and enrolled in credit recovery in summer 2012. Although the two cohorts were similar at baseline, there were some implementation differences due both to shifting district policy on summer school and changes made to the online course platform. Thus, we will examine overall differences by treatment (online vs. f2f) but also examine the extent to which results are consistent (or not) across the two cohorts—a form of replication within the same study. Exploring similarity or differences in the implementation and impact between the two cohorts will allow us to better isolate the active ingredients of the intervention—what is essential

to the impact of an online relative to a f2f credit recovery course—from those factors that can shift over time or across contexts.

Setting:

The setting for this study is CPS high schools with the largest number of students who failed Algebra I. CPS is the third-largest U.S. district, which, in 2011, served more than 435,000 students in 666 schools, of which 116 were public high schools and 27 were public charter high schools. School reform and improvement have been high priorities in Chicago for a number of years, as high schools in CPS continue to struggle with low student performance and low graduation rates (Kahne, Sporte, de la Torre, & Easton, 2006). The overall graduation rate in the district is 65% and the average composite ACT score for CPS juniors is 18, lower than the 20.5 for juniors in the state of Illinois and well below the score required by most colleges (<http://www.cps.edu/Schooldata/Pages/Schooldata.aspx>).

Population / Participants / Subjects:

Participating schools in CPS were recruited based on the number of Algebra I failures they had in 2010, thus these schools had higher Algebra I failure rates and were larger than other high schools in CPS, on average. They were similar to other schools in the district in terms of the percentage of low income and special education students served (see Tables 1 and 2 in Appendix B). The target students were first-time freshmen who failed second-semester Algebra I.

Cohort 1: In summer 2011 we randomly assigned a total of 592 students to 18 pairs of online and f2f sections of second semester algebra (Algebra IB) in 15 CPS high schools. Of the 592 students, 88% were eligible for free/reduced-priced lunch, 9% were eligible for special education services, and 37% were female. The students were 58% Hispanic, 36% African American, and 5% white. Thirty-eight percent of students were known to have failed first-semester algebra.

Cohort 2: In summer 2012, we randomly assigned a total of 792 students to 20 pairs of online and f2f sections in 13 schools. Of the 792 students, 83% were eligible for free or reduced-price lunch, 10% were eligible for special education services, and 38% were female. The students were 58% Hispanic, 29% African American, and 12% other race/ethnicities and 40% were known to have failed first-semester algebra.

Intervention / Program / Practice:

The theory of action behind this study is represented in Figure 1 in Appendix B. Students fail algebra because they are poorly engaged in the class and put in little effort—the strongest predictors of 9th grade course failure are students’ attendance and work effort (Allensworth & Easton, 2007). Low engagement leads students to learn little and to subsequently fail. Because they lack an understanding of algebra, they struggle in subsequent classes, particularly in mathematics and science. Failure in these classes, combined with failure in algebra, leads students to have insufficient credits to graduate. As the likelihood of obtaining sufficient credits diminishes, students eventually drop out.

Online credit recovery potentially interrupts this process by being a more individualized, interactive experience, with personal support and monitoring provided by on-site mentors. These characteristics—individualization, interactive pedagogy, and personal support—have all been associated with greater engagement and learning (Archambault et al., 2010; Lee & Smith, 1999; Newmann et al., 1996; Slavin & Madden, 1989). Students should be more engaged and more likely to persist in the course, thus more likely to learn algebra content and receive course credit. These short-term outcomes should lead to improvements in other short-term achievement

outcomes, including scores on the mathematics exam (that includes an algebra portion) taken in the fall of 10th grade. Better algebra skills should also make students more likely to pass their subsequent mathematics and science classes, and make greater progress toward graduation.

The online course used in the study was developed by Aventa Learning, a provider that CPS had used extensively. Students took the course in computer labs at their local high schools, in the presence of a trained on-site mentor. They also had an online algebra teacher, provided by Aventa. The control condition was the typical f2f Algebra IB course offered in schools participating in the study. The course was taught by a teacher in each participating school.

Research Design:

In this study we randomly assigned students to either online or f2f Algebra I credit recovery courses in participating schools, on site on the first days of summer school. The focus of student recruitment was on freshmen who failed second semester Algebra, which has much higher failure rates than first semester algebra. Students were blocked by gender and whether they passed or failed first semester algebra. On-site random assignment was used to prevent the inclusion of large numbers of no-shows in the intent-to-treat (ITT) analyses.

In summer 2011, we randomly assigned a total of 591 students across 36 sections (18 online and 18 f2f), yielding an average of 16 students per section. In summer 2012, we randomly assigned a total of 792 students across 40 sections (20 online and 20 f2f), yielding an average of 20 students per section. Table 3 in Appendix B shows the distribution of students by and across condition on the blocking characteristics. The study was designed to have sufficient power to detect effects on student achievement and other outcomes ranging between 0.14 and 0.19 standard deviations, for analyses conducted separately by cohort.

Data Collection and Analysis:

This paper focuses on outcomes based on the following measures, which are available for both cohorts as of fall 2013:

- Credit recovery course grades and credit attainment (administrative records).
- Student perceptions of their credit recovery course e.g., classroom engagement and personalism, perceived difficulty of the course (study-administered survey).
- A study-administered end-of-course algebra assessment, taken by all consenting students participating in the credit recovery courses in summers 2011 and 2012.
- The PLAN assessment (also known as the “pre-ACT”), including algebra subtest scores taken in fall 2011 by students in Cohort 1 and fall 2012 for Cohort 2.
- Math courses taken and grades earned in the school year following summer credit recovery (grade 10 for students who were promoted).

Baseline characteristics including prior achievement and demographics have been used to test for equivalence of the treatment and control groups and as covariates in the impact analyses. As shown in Appendix B, Tables 4 and 5, there were no significant differences observed between students randomly assigned to the online or f2f courses.

The central research questions regarding the efficacy of online Algebra I for credit recovery versus f2f Algebra I for credit recovery are tested using fixed effects models that compare the outcomes of students in the online classes with those in the f2f classes, separately by cohort. We

also included student-level characteristics for residual covariate adjustment. Analyses of continuous outcomes employ fixed-effects linear regression models while analyses of binary outcomes (e.g. credit recovery) employ fixed effects logistic regression models.

In addition to the online vs f2f comparison analyses, this paper will also present findings from descriptive analyses of the implementation of the summer 2011 and 2012 credit recovery courses, using data from classroom observations, teacher/student surveys, and daily mentor logs.

Findings / Results:

Preliminary findings show that scaled scores on the end-of-course assessment were significantly lower ($p=0.02$, $d=-0.18$) for online ($M=272.37$, 38% correct) than f2f students ($M=279.75$, 41% correct) but only for cohort 2 (no significant differences for cohort 1). In both cohorts, students in the online course earned significantly lower grades ($p<0.001$, see Appendix B, Figure 2) and were less likely to recover credit than students in the f2f course. In 2011, 58% of students assigned to the online course successfully recovered credit compared with 65% of students assigned to the f2f classes ($p=0.033$). Similarly in 2012, 72% of students assigned to the online course recovered credit compared with 82% of students in f2f classes ($p<0.001$).

Student attitudes toward math and their credit recovery course were similar by condition, except that students perceived the online course to be significantly more difficult than the f2f course in both cohorts ($p<0.001$, see Appendix B, Tables 6 and 7).

As 10th graders, Cohort 1 students showed no significant differences by condition in performance on the PLAN composite ($p=0.585$) or the mathematics ($p=0.236$) or algebra subtests ($p=0.143$) – see Appendix B, Table 8. Students in the online course were marginally significantly more likely to take Geometry or a more advanced course in Grade 10 (99% online vs. 88% f2f, $p=0.083$, see Appendix B, Table 9) but were not more likely to pass it ($p=0.582$, see Appendix B, Table 10). The proposed paper will include the parallel findings for Cohort 2 students as 10th graders using administrative records that will be available in fall 2013.

Implementation analyses include descriptive analyses and correlational analyses of the links between implementation factors and student outcomes, separately for each cohort. Preliminary implementation analyses archived online course data and classroom materials show that the online course presented a standard, second-semester algebra program to students in both cohorts. Topics were presented sequentially and students had limited opportunity to go back to earlier content. Due to the provider's migration of their courses to an upgraded platform, some students in Cohort 2 experienced technical challenges that may have impeded their progress in the course. In terms of mentor practices, the mentors provided more technical support to students in Cohort 2 than did mentors for Cohort 1. The f2f classes were a mix of first- and second-semester algebra topics; they thus seemed to be more flexible with content based on teacher perceptions of student needs, which was often lower-level content than second-semester algebra. Student engagement was observed to be relatively high and similar across cohorts and conditions.

Conclusions:

We will draw initial conclusions from this rigorous experimental study on the relative impact of online vs. standard f2f Algebra I credit recovery course on students' likelihood of recovering the credit, mathematics achievement, and subsequent math coursetaking and performance for two separate cohorts of students. In addition, by linking implementation with outcome data for two separate cohorts, we will also be able to make limited inferences about possible contextual factors affecting the implementation and impact of online Algebra I credit recovery courses.

Appendix A. References

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Appendix B. Tables and Figures

Figure 1. Theory of Action Behind Summer Online Algebra Credit Recovery

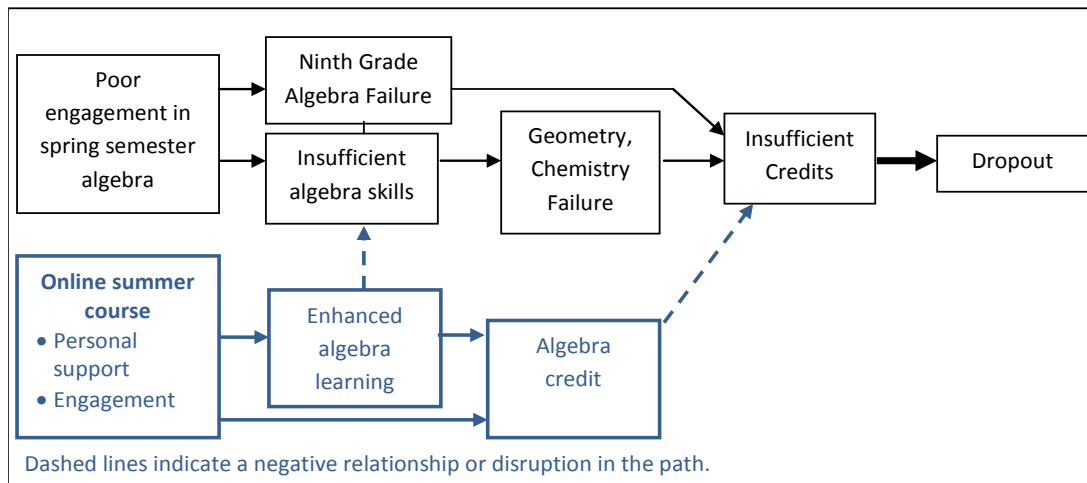


Table 1. Characteristics of CPS High Schools Participating in Credit Recovery Study in Summer 2011 and District High Schools Overall, as of 2010

Characteristics	2011 Study Schools		All CPS high schools
	Average Number	Average Percent	Average Percent
Female	906	50.7%	49.6%
Race/Ethnicity			
White	136	6.0%	4.7%
African American	628	42.4%	59.4%
Hispanic	957	48.0%	32.5%
Asian	4	0.2%	0.2%
Native American	8	0.4%	0.2%
Other Race	17	0.9%	1.2%
Eligible for free or reduced-price lunch	1468	91.5%	91.3%
Home language not English	975	48.3%	31.2%
Eligible for special education services	269	15.4%	18.9%

Number of study schools is 15. Averages are calculated from all students in grades 9-12 active during the fall semester, 2010. District averages include all schools with students in grades 9-12 (total school N=150).

Table 2. Characteristics of CPS High Schools Participating in Credit Recovery Study During Summer 2012 and District High Schools Overall, as of 2011

Characteristics	2012 Study Schools		All CPS high schools
	Average Number	Average Percent	Average Percent
Female	907	49.6%	49.4%
Race/Ethnicity			
White	179	8.2%	4.7%
African American	497	33.3%	58.4%
Hispanic	1076	54.5%	33.1%
Asian	2	0.1%	0.2%
Native American	8	0.4%	0.2%
Other Race	22	1.4%	1.3%
Eligible for free or reduced-price lunch	1572	91.0%	91.6%
Home language not English	1074	53.4%	31.4%
Eligible for special education services	287	16.0%	19.2%

Number of study schools is 13. Averages are calculated from all students in grades 9-12 active during the fall semester, 2011. District averages include all schools with students in grades 9-12 (total school N=150).

Table 3: Number and Percentage of Students per Condition by Block

Condition	Gender	Passed Algebra IA		Failed Algebra IA		Algebra IA Status Unknown		Total
		Number	Percent	Number	Percent	Number	Percent	Number
Cohort 1 – Summer 2011								
F2F	Female	45	16%	27	9%	30	10%	102
	Male	70	24%	59	21%	56	20%	185
	<i>Total</i>	<i>115</i>	<i>40%</i>	<i>86</i>	<i>30%</i>	<i>86</i>	<i>30%</i>	<i>287</i>
Online	Female	44	14%	36	12%	35	12%	115
	Male	73	24%	61	20%	55	18%	189
	<i>Total</i>	<i>117</i>	<i>38%</i>	<i>97</i>	<i>32%</i>	<i>90</i>	<i>30%</i>	<i>304</i>
Cohort 2 – Summer 2012								
F2F	Female	56	14%	52	13%	41	10%	149
	Male	83	21%	95	24%	70	18%	248
	<i>Total</i>	<i>139</i>	<i>35%</i>	<i>147</i>	<i>37%</i>	<i>111</i>	<i>28%</i>	<i>397</i>
Online	Female	53	13%	55	14%	44	11%	152
	Male	81	21%	93	24%	69	17%	243
	<i>Total</i>	<i>134</i>	<i>34%</i>	<i>148</i>	<i>37%</i>	<i>113</i>	<i>29%</i>	<i>395</i>

Source. Study records.

Table 4. Baseline Characteristics of Cohort 1 (Summer 2011)

Characteristic	Online	F2F	<i>p</i> -value
Mean spring 2010 Explore math scaled score	13.45 (2.92)	13.25 (2.96)	0.193
Mean concentrated poverty (2009 ACS) ^a	0.13 (0.75)	0.12 (0.74)	0.912
Mean social status (2009 ACS) ^b	-0.57 (0.87)	-0.54 (0.85)	0.743
Mean number of unexcused absences (2010-2011 school year)	32.05 (23.48)	30.49 (23.32)	0.289
Percent first-time freshman	88	91	0.194
Percent special education	10	7	0.216
Percent African American	38	35	0.226
Percent Latino	56	59	0.253
Percent Other Race (non-Latino, non-African American)	6	6	0.821
Percent Suspended (2010-2011 school year)	46	46	0.830
Percent Moved Schools (2010-2011 school year)	5	5	0.801
Percent Female (blocking variable)	38	36	0.629
Percent Passed Algebra 1A (blocking variable)	39	40	0.574
Percent Failed Algebra 1A (blocking variable)	32	30	0.575
Percent Unknown Pass/Fail in Algebra 1A (blocking variable)	30	30	0.989

Note: Sample includes 15 schools; 591 students (304 Online, 287 F2F). Values represent unadjusted means. Differences in characteristics by condition were tested using a model that modeled schools and summer school session as fixed effect to account for the clustering of students within schools and summer school session. Figures in parentheses are standard deviations. a. Concentration of poverty is a standardized measure of poverty for the census block group in which the student lives. A large positive number indicates a high level of poverty concentration; a large negative number indicates a low level of poverty concentration. This measure is calculated from Census data (the percent of adult males employed and the percent of families with incomes above the poverty line), and is standardized such that a “0” value is the mean value for census block groups in Chicago.

b. Social status is a standardized measure of educational attainment/employment status for the census block group in which the student lives. A large positive number indicates a high social status; a large negative number indicates a low social status. This measure is calculated from Census data (mean level of education of adults and the percentage of employed persons who work as managers or professionals), and is standardized such that a “0” value is the mean value for census block groups in Chicago.

Source: Chicago Public Schools (CPS) Administrative Data

Table 5. Baseline Characteristics of Cohort 2 (Summer 2012)

Characteristic	Online	F2F	<i>p</i> -value
Mean spring 2011 Explore math scaled score	13.64 (2.83)	13.78 (2.88)	0.354
Mean concentrated poverty (2009 ACS) ^a	-0.03 (0.79)	0.01 (0.76)	0.574
Mean social status (2009 ACS) ^b	-0.40 (0.86)	-0.45 (0.87)	0.475
Mean number of unexcused absences (2011-2012 school year)	24.03 (20.85)	25.86 (21.51)	0.246
Percent first-time freshman	87	88	0.586
Percent special education	9	10	0.521
Percent African American	31	28	0.107
Percent Latino	58	59	0.533
Percent Other Race (non-Latino, non-African)	12	13	0.511

Characteristic	Online	F2F	p-value
American)			
Percent Suspended (2011-2012 school year)	34	37	0.391
Percent Moved Schools (2011-2012 school year)	5	6	0.437
Percent Female (blocking variable)	39	38	0.740
Percent Passed Algebra 1A (blocking variable)	34	35	0.688
Percent Failed Algebra 1A (blocking variable)	38	37	0.790
Percent Unknown Pass/Fail in Algebra 1A (blocking variable)	29	28	0.868

Note: Sample includes 13 schools; 792 students (395 Online, 397 F2F). Values represent unadjusted means. Differences in characteristics by condition were tested using a model that modeled schools and summer school session as fixed effect to account for the clustering of students within schools and summer school session. Figures in parentheses are standard deviations.

a. Concentration of poverty is a standardized measure of poverty for the census block group in which the student lives. A large positive number indicates a high level of poverty concentration; a large negative numbers indicates a low level of poverty concentration. This measure is calculated from Census data (the percent of adult males employed and the percent of families with incomes above the poverty line), and is standardized such that a “0” value is the mean value for census block groups in Chicago.

b. Social status is a standardized measure of educational attainment/employment status for the census block group in which the student lives. A large positive number indicates a high social status; a large negative numbers indicates a low social status. This measure is calculated from Census data (mean level of education of adults and the percentage of employed persons who work as managers or professionals), and is standardized such that a “0” value is the mean value for census block groups in Chicago.

Source: Chicago Public Schools (CPS) Administrative Data

Figure 2. Credit Recovery Course Grades by Condition and Cohort

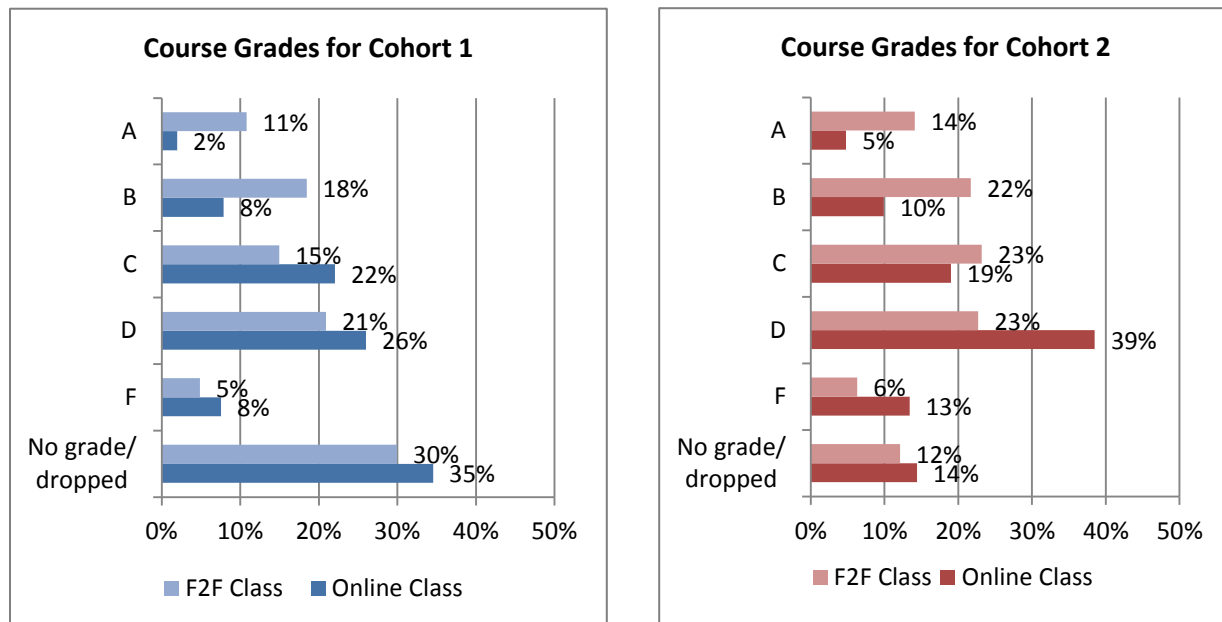


Table 6. Impact of Online vs. F2F Algebra I Credit Recovery on Student Survey Outcomes (Cohort 1)

Survey Outcome	Online		F2F		Impact Estimate			
	Mean	Std.	Mean	Std.	β (S. E.)	t	p -value	d
Engagement	1.52	0.48	1.54	0.55	-0.04(0.05)	-0.73	0.464	-0.07
Classroom Personalism	2.13	0.50	2.07	0.57	0.04 (0.05)	0.82	0.411	0.07
Usefulness of Mathematics	1.92	0.60	1.84	0.65	0.08 (0.06)	1.21	0.228	0.12
Liking/Confidence in Mathematics	1.41	0.70	1.46	0.67	-0.05 (0.07)	-1.77	0.441	-0.07
Academic Press: Teacher Expectations	2.26	0.49	2.24	0.58	0.01 (0.05)	0.10	0.918	0.02
Academic Press: Class Difficulty	1.79	0.59	1.49	0.55	0.29 (0.06)	4.98	<0.001	0.53

Notes: Sample includes 15 schools; 390 students (223 Online, 167 F2F). Values represent unadjusted means and standard deviations. Beta coefficients are unstandardized. The effect size d was calculated by dividing the unstandardized coefficient by the standard deviation of the control (f2f) condition.

Source: Study Administered Student Survey

Table 7. Impact of Online vs. F2F Algebra I Credit Recovery on Student Survey Outcomes (Cohort 2)

Survey Outcome	Online		F2F		Impact Estimate			
	Mean	Std.	Mean	Std.	β (S. E.)	t	p -value	d
Engagement	1.53	0.43	1.53	0.49	-0.01(0.04)	-0.35	0.723	-0.02
Classroom Personalism	2.15	0.54	2.10	0.54	0.04 (0.04)	0.82	0.414	0.07
Usefulness of Mathematics	1.81	0.61	1.79	0.70	-0.00 (0.06)	-0.01	0.995	0.00
Liking/Confidence in Mathematics	1.41	0.70	1.46	0.70	-0.15 (0.06)	-2.54	0.011	-0.21
Academic Press: Teacher Expectations	2.28	0.53	2.28	0.57	0.01 (0.05)	0.14	0.893	0.02
Academic Press: Class Difficulty	1.80	0.60	1.48	0.57	0.35 (0.05)	7.02	<0.001	0.61

Note: Sample includes 15 schools; 555 students (282 Online, 273 F2F). Values represent unadjusted means and standard deviations. Beta coefficients are unstandardized. The effect size d was calculated by dividing the unstandardized coefficient by the standard deviation of the control (f2f) condition.

Source: Study Administered Student Survey.

Table 8. Impact of Online vs. F2F Algebra I Credit Recovery on Grade 10 PLAN Assessment Scores (Cohort 1)

PLAN Test/Subtest	Online		F2F		Impact Estimate			
	Mean	Std.	Mean	Std.	β (S. E.)	t	p -value	d
Composite	14.19	2.34	14.20	2.36	0.13 (0.23)	0.55	0.585	0.06
Algebra	5.60	2.32	5.36	2.27	0.33 (0.22)	1.47	0.143	0.15
Mathematics	14.30	2.98	13.96	3.24	0.38 (0.32)	1.21	0.236	0.12

Note: Sample includes 15 schools; 300 students (159 Online, 141 F2F). Values represent unadjusted means and standard deviations. Beta coefficients are unstandardized. The effect size d was calculated by dividing the unstandardized coefficient by the standard deviation of the control (f2f) condition.

Source: Chicago Public Schools (CPS) Administrative Data

Table 9. Impact of Online vs. F2F Algebra I Credit Recovery on Students' Likelihood of Taking Geometry or a More Advanced Course in 2011-2012 (Cohort 1)

Online	F2F	Impact Estimate		
Percent	Percent	Odds Ratio (S. E.)	z	p-value
90.04	87.89	1.82 (0.63)	1.74	0.083

Note: Sample includes 15 schools; 464 students (241 Online, 223 F2F). Values represent unadjusted percentages.
Source: Chicago Public Schools (CPS) Administrative Data

Table 10. Impact of Online vs. F2F Algebra I Credit Recovery on Students' Likelihood of Earning Credit in Geometry in 2011-2012 (Cohort 1)

Online	F2F	Impact Estimate		
Percent	Percent	Odds Ratio (S. E.)	z	p-value
39.17	42.35	0.88 (0.21)	-0.55	0.582

Note: Sample includes 15 schools; 413 students (217 Online, 196 F2F). Values represent unadjusted percentages.
Source: Chicago Public Schools (CPS) Administrative Data