Paper 1: Study Design and Impact Results

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Background / Context:
The consequences of failing core academic courses during the first year of high school are dire. More students fail courses in ninth grade than in any other grade, and a disproportionate number of these students subsequently drop out (Herlihy, 2007). As shown in Chicago and elsewhere, academic performance in core courses during the first year of high school is the strongest predictor of eventual graduation (Allensworth & Easton, 2005). Spearheaded by research from Chicago and other large U.S. districts, the use of "early warning" data systems to identify students at risk of academic failure and then appropriately intervene is now widely recommended (Dynarski et al., 2009; Heppen & Therriault, 2008; Jerald, 2006) and gaining momentum around the country. Identification is a critical first step, but it is only the first step. There is a lack of critical information about the types of interventions that can, in fact, get off-track students back on track for graduation and improve schools' graduation rates.

Algebra failure is of particular concern in high schools across the country. It is considered a key gatekeeper for higher-level mathematics course-taking in high school and for college enrollment (Adelman, 2006; Gamoran & Hannigan, 2000). Yet, pass rates are consistently low in many places. For example, at least 20% of ninth graders in Michigan fail Algebra I (Higgins, 2008). Six years after the implementation of an initiative to increase access to algebra, failure rates for freshmen in Milwaukee were 47% (Ham & Walker, 1999). In Los Angeles, 44% of ninth graders failed Algebra I (Helfand, 2006). In the Chicago Public Schools (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. Identifying ways that students can get back on track is of utmost policy importance.

Credit recovery is one strategy to address high failure rates. Credit recovery programs offer students an opportunity to retake classes that they failed 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 popular strategy for credit recovery: over 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 and initial implementation of a randomized control trial that was designed to strengthen the evidence base for online credit recovery. The study tests the (1) the impact of online Algebra I for credit recovery against the standard face-to-face (f2f) version of the course, and (2) the effects of offering expanded credit recovery options with online algebra, relative to business as usual (i.e., summer programming that schools would offer in the absence expanded credit recovery efforts).

Purpose / Objective / Research Question / Focus of Study:
As described in the Symposium Justification, this efficacy trial is funded by a grant from the Institute of Education Sciences (IES), which provided resources to CPS high schools to implement Algebra I credit recovery courses during the summers of 2011 and 2012—half online and half f2f. The study is designed to answer a set of research questions that address the four broad aims previously described. This paper focuses on the first aim, which is test the efficacy of online Algebra I for credit recovery, compared with standard f2f Algebra I for credit recovery.

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, serving more than 404,151 students in 681 schools, of which 116 are public high schools and 27 are public charter high schools. The overall graduation rate in the district is 65.4%. The study team recruited a total of 15 CPS high schools to participate in the study in 2011, and 13 CPS high schools in 2012. These schools were selected and recruited for participation because they had the largest number of students who failed the second semester of Algebra I in the 2009-2010 school year, did not otherwise have existing expanded summer credit recovery programs in place, and were open for summer school (e.g., not undergoing renovation). The characteristics of the participating schools are shownin Tables 1 and 2.

Population / Participants / Subjects:
The target population for this study was first-time freshman who failed Algebra IB. Student recruitment focused on freshmen that failed second semester Algebra because they are positioned to get back on track in mathematics if they recover the ½ credit early in high school. Students were blocked by gender and whether they passed first semester Algebra and then randomly assigned to condition on site, on the first day of summer school.

In year 1 (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 38% were female. The students were 57% Hispanic, 36% African American, and 5% white. Thirty-eight percent of students were known to have failed first-semester algebra. In year 2 (summer 2012), we randomly assigned a total of 792 students to 20 pairs of online and f2f sections in 13 schools. The cohort 2 student sample was 38% female and 37% were known to have failed first-semester algebra.

Improvement Initiative / Intervention / Program / Practice:
The study was designed to test whether at-risk students who failed second semester Algebra I can achieve higher rates of success if they take an online course for credit recovery than if they re-took the failed course in the standard f2f format. 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 in two ways. First, the delivery can be a more individualized, interactive experience. Furthermore, students receive personal support and monitoring from 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 in recent years. 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 is the typical f2f Algebra IB course offered in schools participating in the study. The course followed the standard CPS Algebra I curriculum and was taught by a teacher in each participating school.

Research Design:
The study employs an experimental design with on-site student-level random assignment of students to either online or f2f Algebra I credit recovery courses in CPS high schools. Participating schools were those with Algebra I failure rates sufficient to support the study. The focus of student recruitment was on freshmen who failed second semester Algebra because they are positioned to get back on track in mathematics if they recover the ½ credit early on in high school. Students were blocked by gender and whether they passed or failed first semester Algebra and then randomly assigned to condition on site, on the first days of summer school. On-site random assignment prevented the inclusion of large numbers of no-shows in the intent-to-treat (ITT) analyses. Tables 2 and 3 in Appendix B show the distribution of students by and across condition on the blocking characteristics for cohorts 1 and 2.

Data Collection and Analysis:
To examine whether participation in credit recovery courses affects the future performance of students in mathematics, the study uses achievement and course-taking data as well as annual data on students' dropout/persistence status and, ultimately, graduation status. In this paper we focus on the following outcomes for both cohorts:

1) Measures of **short-term learning in algebra**, including:
    - A study-administered end-of-course assessment that includes a range of Algebra I topics. The assessment was administered to all consenting students participating in the credit recovery courses in summers 2011 and 2012.
    - The PLAN assessment algebra subtest scores.

2) **Grades in the credit recovery courses and credit attainment**, collected via administrative records
3) **Student engagement and attitudes toward math**, collected via surveys administered at the end of summer session in both years
4) **Enrollment status** for the year following participation in the study (2011-12 for cohort 1 and 2012-13 for cohort 2).
5) **Math and science course performance in grade 10**.

Mathematics achievement outcomes (end-of-course assessment of algebra learning and 10th grade PLAN algebra subtest) and course performance (grades) are modeled as a function of students' pretest scores and intervention status (online or f2f).[2] Analyses with binary outcomes (e.g. passing credit recovery course) employ fixed-effects logistic regression models.

Findings / Results:
Impact analyses to date show that algebra posttest scores were not significantly different by condition in cohort 1, but were higher among students in f2f credit recovery than online in cohort 2 (Hedges' $g = -0.23$; $p = .035$). Students in the f2f classes had higher grades that those in the online course in both cohorts (Hedge's $g = -0.40$ and -0.58, respectively, both p's < 0.001). While the majority of students in both conditions successfully recovered the algebra credit, rates of credit recovery were higher in the f2f than online condition; however, the difference was statistically significant only for cohort 2. (Credit recovery rates for Cohort 1 were 66% online vs. 70% f2f; $p = 0.483$, and for Cohort 2 were 68% online vs. 79% f2f; $p < 0.001$.) Algebra PLAN scores were not significantly different by condition in either cohort, nor was the likelihood of taking or passing Geometry the following year. (For example, in cohort 1, 86% of f2f students and 85% of online students enrolled in second semester Geometry the following spring, and 45% of f2f students and 42% of online students passed the course; p's $= 0.655$ and 0.611 for taking and passing, respectively.) Student attitudes were similar by condition in both cohorts, except that the online course was viewed as more difficult in both cohorts, and students' reported liking of and confidence in mathematics was higher in the f2f than online condition in cohort 2.

Conclusions:
Findings to date suggest that for some short-term outcomes, f2f credit recovery seems to benefit students more than an online course. However, most students successfully recovered credit in in both conditions. The course content of the online course was more difficult, which may have benefitted some students but may have been inaccessible for others. In combination, the findings presented in this paper will provide insights about the impacts of online credit recovery that are otherwise unavailable in the research literature.

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[2] Although randomization does not require covariate adjustments to obtain unbiased estimates of the intervention's effects, the inclusion of covariates strongly related to the outcome, particularly pretest scores, improves statistical precision of the parameter estimates (Bloom, Richburg-Hayes, & Black, 2007; Raudenbush, Martinez, & Spybrook, 2007).