AIR®
AMERICAN INSTITUTES FOR RESEARCH®

Getting Back on Track

What Math Content Is Taught and Learned in Online and Face-to-Face Algebra Credit Recovery Courses?

RESEARCH BRIEF 4

February 2017

AUTHORS OF THIS RESEARCH BRIEF are Kirk Walters (American Institutes for Research [AIR]), Jessica Heppen (AIR), Suzanne Taylor (AIR), Nicholas Sorensen (AIR), Jordan Rickles (AIR), and Peggy Clements (AIR).

THE ***BACK ON TRACK STUDY*** is an investigation about credit recovery in Algebra I for students who fail the course in ninth grade. Students who fail Algebra I are required to recover the credit during high school to earn a diploma, and online credit recovery courses have become a popular strategy in schools and districts around the country. The *Back on Track Study* examines the impact of an online credit recovery Algebra I course compared with a standard face-to-face version of the course; both courses were offered the summer after ninth graders failed Algebra I. The study was funded by the U.S. Department of Education's Institute of Education Sciences, and conducted by American Institutes for Research and the University of Chicago Consortium on School Research, in partnership with Chicago Public Schools (CPS). This study is a randomized controlled trial that was designed to address two types of questions:

1. **What is the impact of online versus face-to-face Algebra I courses for credit recovery?**
2. **What is the long-term effect of offering expanded credit recovery options early in high school?**

The study took place in 17 CPS high schools that offered both online and face-to-face Algebra I credit recovery courses in summer 2011 and summer 2012. A total of 1,224 ninth graders participated in the study by enrolling in a second-semester Algebra I course for credit recovery during the summer after failing the class. Students were randomly assigned to take the online or face-to-face course.

This research brief is one in a series for the *Back on Track Study* that presents the findings regarding the relative impact of online versus face-to-face Algebra I credit recovery on students' academic outcomes, aspects of implementation of the credit recovery courses, and the effects over time of expanding credit recovery options for at-risk students.

RESEARCH BRIEFS IN THIS SERIES

Getting Back on Track: Comparing the Effects of Online and Face-to-Face Credit Recovery in Algebra I

This brief compares educational outcomes through the second year of high school for students who took online credit recovery versus face-to-face credit recovery in 17 CPS high schools.

Getting Back on Track: The Role of In-Person Instructional Support for Students Taking Online Credit Recovery

This brief describes the role of in-class mentors who supervised students taking the online course and examines whether students benefited from additional instructional support from their in-class mentors.

Getting Back on Track: Who Needs to Recover Algebra Credit After Ninth Grade?

This brief describes the characteristics of students who failed Algebra I in ninth grade across CPS high schools, to better understand the population of students who are served by credit recovery courses.

Getting Back on Track: What Math Content Is Taught and Learned in Online and Face-to-Face Algebra Credit Recovery Courses?

This brief evaluates the content provided in online and face-to-face algebra credit recovery courses and reveals possible differences based on instructor preferences and district guidelines.

Please visit www.air.org/CreditRecovery to access all of the research briefs and for more information about the *Back on Track Study.*

The Back on Track Study was supported by Grant R305A110149 from the Institute of Education Sciences, U.S. Department of Education to the American Institutes for Research. The opinions expressed are those of the authors and do not represent the views of the Institute or the U.S. Department of Education.

Online courses can serve as a practical way for students to recover credit in courses they have failed. These courses provide flexibility and convenience for schools and students; some may also have the potential to present course content in a more engaging and customized way than a standard face-to-face course. When comparing online and face-to-face courses, it is important to consider the content presented in each format. Online and face-to-face courses with the same course title do not necessarily address the same topics in the same order. Online courses specify particular topics that students must master to recover course credit, whereas the content within face-to-face courses may vary based on the preferences of the teacher. This information is important to understanding what it means for students to earn course credits. As districts increasingly turn to online credit recovery to keep at-risk students on the path toward graduation, these differences in course content are especially salient.

The *Back on Track Study,* conducted by American Institutes for Research and the University of Chicago Consortium on School Research, is an ongoing study of online versus face-to-face credit recovery for at-risk ninth graders. The study focused on the "gateway" course of Algebra I, comparing short- and long-term outcomes for students who retook the second semester of algebra (Algebra IB) during summer school. This research brief is one in a series investigating the implementation and impacts of the credit recovery courses in the study. This brief specifically focuses on the math content in the two types of courses and addresses the following questions:

1. How did the content of the online and face-to-face Algebra IB courses compare? Did the courses cover the same topics, with similar sequencing?
2. How much of the online course did students complete and with what level of mastery?
3. How did grading policies compare across the two types of courses? Were students expected to demonstrate similar levels of mastery to earn particular grades and overall credit?
4. How did students' algebra content knowledge compare in the two types of courses? Did they perform differently on an end-of-course algebra test that measured prealgebra, first-semester, and second-semester algebra content?

What Math Content Is Taught and Learned in Online and Face-to-Face Algebra Credit Recovery Courses? KEY FINDINGS

- All of the online course content covered second-semester (Algebra IB) topics, whereas only 50% of the content in the face-to-face classes covered Algebra IB topics. The other 50% of the content in the face-to-face classes addressed a mix of prealgebra and first-semester (Algebra IA) topics.
- The online course content followed a conventional sequence, within and across Algebra IB units. In contrast, 70% of the content in the face-to-face classes followed a conventional sequence; the other 30% of the face-to-face content appeared to be sequenced haphazardly.
- Students in the online course on average completed less than two thirds of the course and struggled on end-of-unit assessments within the course.
- Students' grades were lower in the online course than in the face-to-face classes. Less than one third of online students earned a grade of "C" or higher, compared with more than half of students in face-to-face classes. Tests and quizzes accounted for about 60% of students' final grades in the online course, compared with about 50% in the face-to-face classes.
- Student scores on the end-of-course algebra test administered for this study were low overall in both types of courses. However, students In the online course scored significantly lower than the face-to-face students on this assessment, including lower on prealgebra, Algebra IA, and Algebra IB item sets.

About the Study

The *Back on Track Study* provided resources to high schools in the Chicago Public School District (CPS) to offer credit recovery courses during the summers of 2011 and 2012 to first-time ninth graders who failed Algebra IB, which is the second semester of Algebra I.

In the study, 1,224 first-year high school students who failed Algebra IB were randomly assigned to either an online summer algebra course or a traditional face-to-face summer algebra course.[1] A total of 76 algebra credit recovery classes (38 online and 38 face-to-face) took place as part of the study. The average number of students in both types of classes was 16. The credit recovery courses were offered during four summer sessions at 17 schools (two sessions in 2011 and two sessions in 2012). Most participating schools held summer school daily for about four hours each day for three to four weeks to meet the 60-hour requirement for a one-semester credit recovery course.

The study tested the effects of online versus face-to-face algebra credit recovery on student academic outcomes and examined the implementation conditions associated with student success in online credit recovery. A companion brief in this series presents the study findings through participating students' second year of high school; these findings are summarized in the sidebar. The study will also examine long-term outcomes, including on-time graduation rates, once data are available.

This brief presents study results that are related to the mathematical content of the online and face-to-face Algebra IB courses and the end-of-course assessment, as well as the grades that students earned in these courses and how those grades were determined. To help situate the study results, we describe the online and face-to-face courses and our approach to analyzing the content of the two types of courses.

Back on Track Study KEY FINDINGS

- The majority of students in the study successfully recovered credit in both types of courses, but students in the online course were less likely to pass than students in the face-to-face course (66% vs. 76%).
- At the end of the course, students in the online course reported that their class was more difficult and less clear regarding grading expectations than students in the face-to-face credit recovery course. Students in the online course also had lower liking of and confidence in math and lower algebra test scores than students in the face-to-face course.
- There were no significant differences between online and face-to-face students in pass rates in subsequent math classes or their likelihood of being on-track for graduation at the end of the second year of high school

(See companion brief, "Getting Back on Track: Comparing the Effects Online and Face-to-Face Credit Recovery in Algebra I," for more details.)

Comparing the Online and Face-to-Face Courses

Online Course

The online course was developed by Aventa/K12 (Aventa), a widely used online course provider. It was organized into five units and 24 lessons. The course included an online teacher, who was certified in secondary mathematics and was hired, trained, and supervised by Aventa. The online teachers and students did not meet in person; rather, teachers communicated directly with students through a learning management system, online chats, and online "whiteboard" demonstrations. The course

[1] The study used a lottery to determine students' assignments. All students had a 50/50 chance of taking the course online or face to face. The use of random assignment ensured that the groups of students are statistically comparable.

content was exclusively second-semester algebra, and it was organized such that all students progressed through the same Algebra IB topics in the same order. This course did not provide students with opportunities to learn any additional content, such as topics from prealgebra or first-semester algebra.

Students took the online course at school, in a computer lab or a classroom, under the supervision of an in-class mentor. The mentors were selected by participating schools and trained by Aventa. Like other online course providers, Aventa strongly recommends using mentors but does not have specific requirements for these personnel, such as subject matter expertise in the credit recovery courses they are supporting. In this study, all but one (97%) mentor were certified teachers and approximately half were certified specifically to teach high school mathematics.[2] Aventa's mentor training program included guidance on how to provide in-person support, which included helping students navigate the curriculum, proctor online assessments, troubleshoot technological issues, and communicate with the online teachers about students' progress. Because subject matter expertise was not a requirement, the in-class mentors were not expected to provide instructional support in specific courses, but they could do so at their discretion.

Face-to-Face Course

CPS required that each summer face-to-face Algebra IB class be taught by a CPS teacher who was certified to teach secondary mathematics. Once schools met this requirement, the face-to-face teachers had autonomy in developing their syllabi and assembling instructional resources for their Algebra IB classes. Such autonomy is consistent with the broader district policy of allowing individual schools to select the kinds of curricular resources they use in their high school math programs. The district does have an approved list of textbooks, but schools are not required to use any of these adopted textbooks and can create or assemble their own curricular resources. Given this context, there was wide variability in the instructional materials used in the summer face-to-face classes. These ranged from textbooks, to supplemental resources (free or available for purchase), to teacher-created handouts and worksheets, to a combination of these resources. These instructional materials also varied in the topics covered; some teachers included prealgebra and first-semester algebra content into their face-to-face classes.

Unlike the in-class mentors in the online course, the face-to-face teachers did not receive any training prior to summer school and none of the face-to-face teachers had access to tablets, laptops, or a computer lab, which would have allowed them to provide students with one-to-one computer access. Thus, the predominant mode of instruction in the face-to-face classes involved a single teacher using the board and printed resources (textbooks, handouts) to convey the material to students.

Content Analysis

To analyze the content in these two types of courses, we reviewed the online course, which was the same across the 38 online sections, and the face-to-face classroom materials, which varied across the 38 face-to-face classrooms.

---

[2] See companion brief in this series, "Getting Back on Track: The Role of In-Person Instructional Support for Students Taking Online Credit Recovery" for an analysis of the role of instructional support in students' success in the online course.

Districts and textbooks vary in how they distinguish first-semester from second-semester algebra content. In general, however, second-semester algebra consists of more complex algebra topics (e.g., systems of equations, quadratics) than first-semester algebra (e.g., solving and graphing linear equations). This is true for Aventa's Algebra IA and IB courses: More complex content is included in Algebra IB, which is similar to what might be found in the second half of a typical Algebra I textbook. Therefore, we used Aventa's IB topics to frame our content analysis of the face-to-face classes, which could include topics outside of second-semester algebra (e.g., prealgebra and first-semester algebra).

The face-to-face teachers provided different levels of specificity for how they used their classroom materials. For example, some teachers shared an annotated table of contents from the single textbook they used, while others submitted each problem set they used for every day of summer school, assembled from multiple resources. Given this variability, we used the most fine-grained unit available to code the extent to which particular algebra topics were covered. If a face-to-face teacher created and submitted a complete set of handouts for the three-week class, for instance, we analyzed the content of each handout against the content covered in the five units and 24 lessons of Aventa's IB course. For teachers who used a textbook and annotated the chapters and lessons they used in their face-to-face classes, we used this grain size of information in our content analysis. For each face-to-face section, and aggregated across all sections, we calculated the extent to which the courses emphasized prealgebra content, first-semester algebra content, and second-semester algebra content. To analyze the sequencing of the content in the face-to-face classes, we used the organizational structure of Aventa's IB course, which consisted of units and several lessons that addressed the larger topic of the given unit. For example, face-to-face teachers who used a textbook and followed the order of chapters and lessons nested within chapters presented the content in a conventional order, similar to the Aventa course.

AVENTA'S ALGEBRA IB ONLINE COURSE UNITS

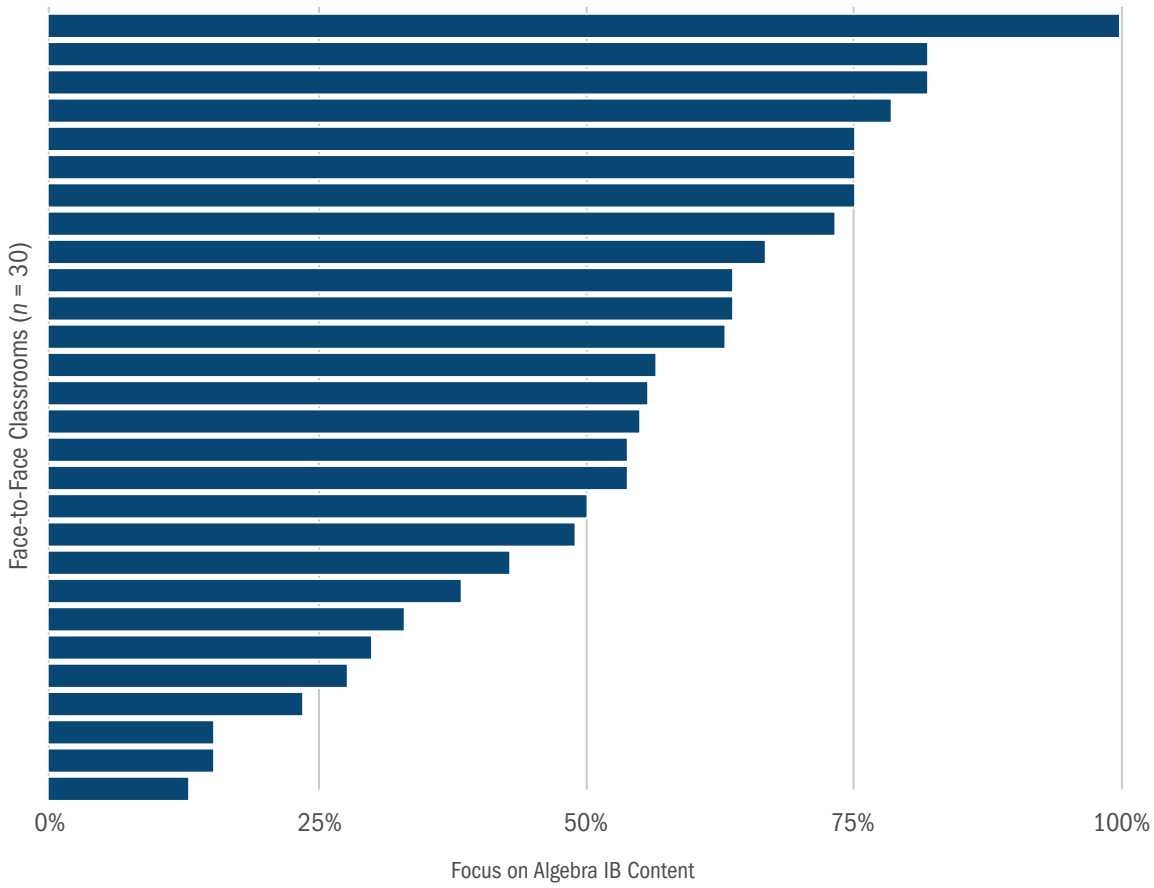
Unit	Lessons
Solving Systems	1–5
Polynomials	6–11
Quadratics and Radicals	12–16
Rational Expressions	17–21
Exponents	22–24

Study Findings

The online course covered Algebra IB content exclusively, but only half of the content covered in the face-to-face classes addressed second-semester algebra

Aventa's Algebra IB course focused entirely on second-semester algebra content. However, given the nature of the subject and the study's focus on struggling students, we anticipated that some of the face-to-face teachers might choose to cover first-semester or even prealgebra topics in their classes to address deficiencies in students' prior knowledge. Our analysis of face-to-face classroom materials indicated that this was the case. On average, only half of the content covered in the face-to-face classes was aligned to the Algebra IB topics in Aventa's course; the other half was a mix of first-semester algebra and prealgebra content. There was wide variability in the content covered across the face-to-face classrooms (Figure 1): One face-to-face class covered Algebra IB content exclusively (100%), whereas two classes did not cover any Algebra IB content (0%).

Figure 1. Focus on Algebra IB Content in the Face-to-Face Classrooms



Note. Two face-to-face classrooms did not cover any Algebra IB content and thus are not depicted in this figure.

The online course followed a conventional sequence of topics, but almost 30% of the face-to-face classes sequenced topics haphazardly

Our analysis of the order in which topics were presented in the online and face-to-face classes also showed differences between the two types of courses. Again, using the conventional sequencing and organization of topics in the Aventa course as an anchor, we found that 72% of the face-to-face classes followed a similar, conventional sequence, and 28% of the face-to-face classes did not. We could not discern why certain topics were introduced at various time points, creating a haphazard configuration of content. For example, lessons appeared to be distinct from each other (e.g., not organized under a common unit, chapter, or theme) or second-semester Algebra I topics were presented prior to first-semester algebra or prealgebra content. The box at the right, taken from the third week of one face-to-face class, illustrates such haphazard organization. Students move from writing expressions and equations to solving inequalities, absolute value

SAMPLE FACE-TO-FACE CLASS TOPICS NOT FOLLOWING A CONVENTIONAL SEQUENCE

Week 3 Lesson Objectives

Monday: Manipulate expressions and equations.

Tuesday: Write expressions, equations, and inequalities.

Wednesday: Solve linear inequalities that require reversing the inequality sign.

Thursday: Solve absolute value equations.

Friday: Solve quadratic equations.

equations, and quadratic equations all in the same week. With more conventional sequencing, there would be tighter connections between writing and simplifying expressions and equations (Monday and Tuesday) and then solving linear equations. However, solving linear equations does not appear in the list of topics covered during the week. Instead, the class moves to solving inequalities, which typically follows solving equations in a conventional sequence, but not with such a narrow focus of solving only inequalities that require reversing the inequality sign (Wednesday). Solving absolute value equations (Thursday) and quadratic equations (Friday) could come after solving inequalities in a conventional sequence, but they would not likely come immediately after a narrow lesson on solving particular types of inequalities, as illustrated here. Taken together, the topics covered during this week were organized nonconventionally and did not progress logically or coherently throughout the week.

On average, online students completed slightly less than two thirds of the Algebra IB course

Unlike the face-to-face courses, the Aventa course system can capture fine-grained data about how far students progress through each lesson and unit, as well as how students perform on end-of-lesson quizzes and end-of-unit assessments. Thus, for the online students, we have a detailed picture of both how much of the curriculum they experienced and how well they mastered it. We cannot paint a similar picture of progression and mastery in the face-to-face classes because classroom materials were collected only at the teacher level and varied greatly in content covered.

Figure 2. Online Course Progression

Average Number of Units and Lessons Completed in the Online Course

Units	Solving Systems					Polynomials						Quadratics and Radicals					Rational Expressions					Exponentials		
Lessons	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

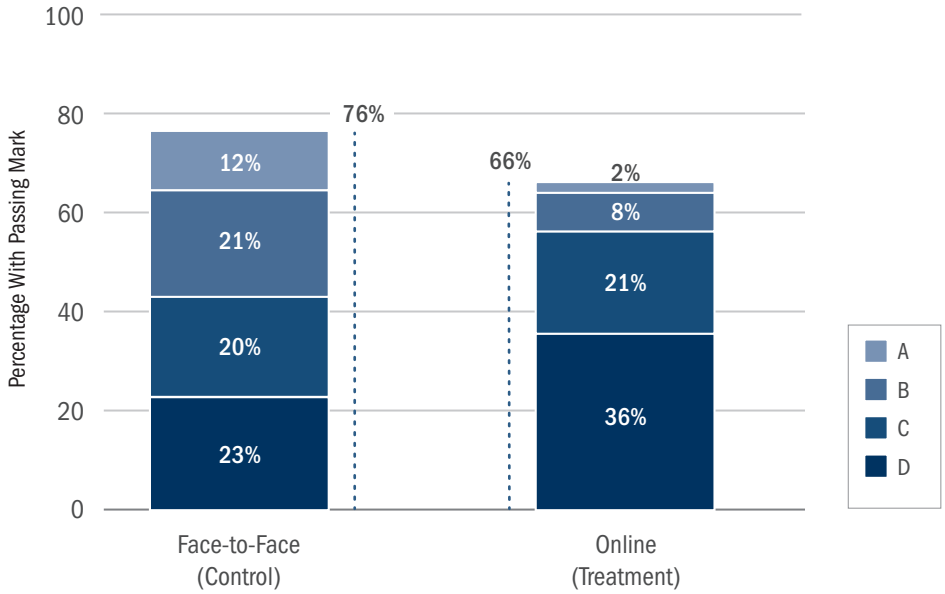
Students in the online course completed 15 of the 24 lessons in the course on average—just under two thirds of the lessons and 2.5 of the five units in the course. The range was wide; some students completed all five units and all 24 lessons, with others completing only a few lessons within the first unit.

Aventa considered students who scored 70% or higher on an end-of-unit test to have mastered that content, although students who failed to reach this threshold were not prevented from beginning the next unit. Students, on average, scored 70% or higher on only 1.7 of the five end-of-unit tests. Because students progressed on average through 2.5 units of the course, many students did not demonstrate mastery on all of the end-of-unit assessments they encountered.

Students' grades were higher in the face-to-face classes than the online classes, which may reflect differences in both the content covered and teachers' grading standards in the two types of classes

We found that face-to-face students earned higher grades and had higher pass rates than students in the online course. One third of face-to-face students earned a "B" or higher in Algebra IB, compared with just 10% of online students. Similarly, more than half of the face-to-face students earned at least a "C," compared with roughly one third of the online students (Figure 3).

Figure 3. Distribution of Summer Passing Grades, by Course Type



A student's grade in a course is influenced by both the content of the course and the teacher's grading criteria. As described previously, many of the face-to-face classes covered "easier" material (prealgebra and Algebra IA) than the online classes (exclusively Algebra IB content). Students tested on easier material are likely to receive higher grades, which likely contributed to higher grades in the face-to-face classes.

With respect to grading criteria, the in-class mentors (not the online teachers) assigned grades to the online students, whereas the face-to-face teachers assigned grades, as typical. The grading criteria used in both types of courses differed, again favoring the face-to-face students. We asked both the mentors and the face-to-face teachers what criteria they used to determine students' final grades. They reported a variety of different criteria, including in-class participation, effort, homework, and assessments. According to the in-class mentors, the online course tests and quizzes accounted for about 60% of students' grades. In the face-to-face classes, tests and quizzes accounted for 50% of the final grade. Because other grading criteria, such as effort and participation, are less rigorous than tests and quizzes, the grading was more lenient for face-to-face students than what the online students experienced.

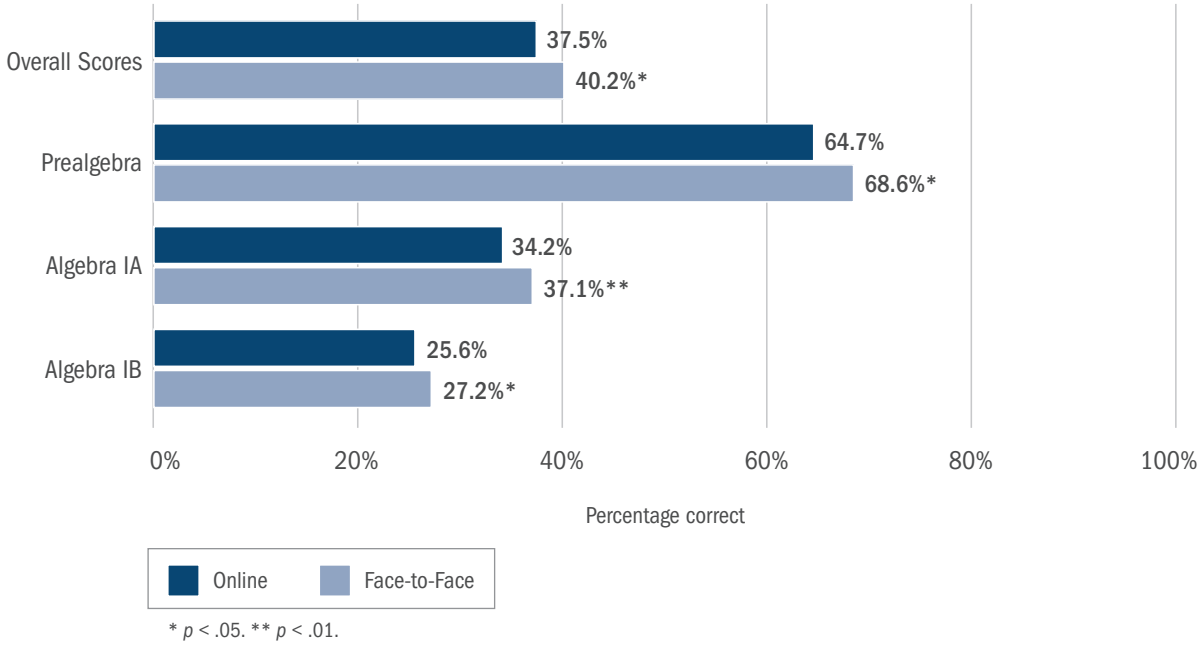
Face-to-face students scored higher than the online students did on the study posttest

Using scaled scores that account for item difficulty, students in the face-to-face classes scored significantly higher than the online students on the end-of-course algebra posttest. The assessment consisted of items used previously in the National Assessment of Educational Progress covering prealgebra and first- and second-semester algebra topics; approximately two thirds of the items assessed prealgebra and first-semester algebra content and one third of the items assessed Algebra IB content.

On average, face-to-face students answered 40% of the posttest questions correctly, and the online students answered 38% of the posttest questions correctly (Figure 3). Face-to-face students also performed significantly better than online students on each of the test's three topic areas: prealgebra

(69% vs. 65% correct), Algebra IA (37% vs. 34% correct), and Algebra IB (27% vs. 26% correct). The differences in favor of the face-to-face students on the prealgebra and Algebra IA items were expected because the face-to-face students had more exposure to this content than online students. The difference in favor of the face-to-face students on the Algebra IB items was more surprising however, because the online course focused exclusively on this content.

Figure 4. Percentage Correct on End-of-Course Algebra Posttest, Overall and by Item Type



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

Although the pattern of significant differences is clear, the accuracy rates suggest that the students performed poorly on the test overall. As expected, students did better on the portions of the test that measured easier algebra topics. For example, more than half of all students (56%) answered the prealgebra item correctly in the example shown in Figure 5. Yet only 9% of all students answered the Algebra IB item below correctly—a percentage that is much lower than chance for a multiple-choice question with five answer choices.

Figure 5. Study Posttest

Prealgebra Item

(**56%** of all students answered this item correctly)

If x = 4, then the value of -4 x is

A. -16

B. -8

C. 8

D. 16

Algebra IB Item

(**9%** of all students answered this item correctly)

Which of the following expressions is equal to $\frac{1}{x+2} - \frac{2}{x+1}$?

A. $\frac{-1}{2x+3}$

B. $\frac{-x-3}{x^2+2}$

C. $\frac{-1}{x^2+3x+2}$

D. $\frac{-x-3}{x^2+3x+2}$

E. $\frac{-x-5}{x^2+3x+2}$

Summary and Implications

In this study, the face-to-face students outperformed the online students in the short term. They earned credits at a higher rate, had higher grades, and performed better on the end-of-course test administered for the study than online students—on items that covered a range of algebra topics, including prealgebra, first-semester algebra, and second-semester algebra content. Thus, in the context of this study and in the short term, retaking second-semester Algebra I as a face-to-face class benefited these students more than taking this online version of the course.

Perhaps the difference in favor of the face-to-face classrooms is a result of the content covered. Rather than focusing exclusively on Algebra IB content, the face-to-face teachers spent roughly half of their time on prealgebra and Algebra IA content—content that many of these at-risk students had not yet mastered in the first or second semester of algebra during the prior school year. By contrast, the particular online course tested in this study did not include a way for students to revisit earlier algebra material that they had not yet mastered. It may have been that this particular online course was just too difficult and not flexible enough to address deficits in prior knowledge for this at-risk population. Yet, it is not easy for teachers to know how much time to spend addressing prior learning deficits at the expense of addressing the current course content. This ongoing tension is especially acute for educators who work with at-risk students, and it is further exacerbated in a short summer school timeframe.

Finally, students in both types of courses struggled on the study posttest—especially the first- and second-semester algebra items—and the majority of students who earned credits only received a grade of "C" or "D." Therefore, neither group of students demonstrated high levels of first- or second-semester algebra knowledge, both of which are critical to succeeding in higher level math classes in high school. It is likely that a much more robust intervention—or combination of interventions—is needed to equip at-risk students with the knowledge, skills, and dispositions they need to succeed in algebra and beyond. Future research might examine both preventative and credit recovery mechanisms—with credit recovery as the last resort—to support these students.

1000 Thomas Jefferson Street NW
Washington, DC 20007-3835
202.403.5000

www.air.org

0237_01/17