In the following report, Hanover Research examines the literature on best practices in secondary math instruction for at-risk students and profiles four school districts with math programs intended to raise at-risk students’ achievement.
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EXECUTIVE SUMMARY AND KEY FINDINGS

INTRODUCTION

Achievement in high-level, secondary math classes is associated with a number of positive college-and-career related outcomes. According to Education Next, for example, college students majoring in math, engineering, and the physical sciences earn, on average, 19 percent more than students in non-math majors; similarly, math SAT scores correlate positively with future earnings as an adult (the same is not true for verbal SAT scores).\(^1\)

However, U.S. high school students routinely rank below their global peers in math and, according to the National Assessment of Educational Progress (NAEP), have not significantly improved in math over the last decade.\(^2\) Moreover, research shows that students who enter Grade 9 behind grade level in math are likely to remain behind in math throughout high school. For this reason, many school districts have launched concerted efforts focused on meeting the needs of high school students with math deficits.

To support district math instruction, in Section I this report examines the literature on the effectiveness of various practices related to improving at-risk student academic achievement in math. In Section II it profiles four secondary math programs that exhibit one or more of the best practices identified in the literature. Below we present key findings from this research.

KEY FINDINGS

- **Practices that may help support at-risk secondary math students** include online credit recovery classes, intervention programs, bridge programs for incoming freshmen, professional development, and double period math classes. The studies that examine the efficacy of these practices typically focus on the foundational math course Algebra I, as opposed to higher-level math courses such as Geometry or Algebra II. Educators and experts believe that students who pass rigorous Algebra I courses with the help of these strategies will be more likely to succeed in higher-level secondary math courses.

- **Effective professional development for secondary math teachers** centers on improving teaching skills and deepening knowledge of the subject material. At-risk students often benefit from untraditional instructional methods. Consequently, teachers should receive professional development focused on implementing student-centered or reform-based techniques and improving content knowledge.

- **Online and software-based programs** can help at-risk secondary students recover credit and develop better math skills. These programs are frequently adaptive and

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respond to students’ skill levels, creating a highly personalized learning experience. However, studies note that online classes are most effective when paired with face-to-face instruction or support.

- **Bridge and pre-Algebra programs can help fill gaps in student learning and prepare at-risk students for secondary-level math courses.** Studies note that summer bridge programs can be effective in helping students who enter Grade 9 behind grade level in math transition into Algebra I in the fall. Similarly, some students may benefit from a pre-Algebra course during their freshman year to fill any skills and knowledge gaps before enrolling in Algebra I.

- **Double period math classes can have long-term, positive effects on student achievement in math and on long-term educational outcomes.** A study of a double period Algebra I policy for at-risk math students in Chicago Public Schools found that participation in the double period course had a positive effect on math skills, college entrance exam scores, high school graduation rates, and college enrollment rates.

- **Informal scholarly consensus suggests that two-year Algebra I courses are detrimental to low-achieving math students.** Although few studies directly examine the effects of multi-year Algebra I courses, researchers and educators often state that this method results in a less rigorous curriculum that is not adapted to students’ needs. Moreover, this method emphasizes low-achieving students’ math deficits in comparison with their peers, rather than closing them.
SECTION I: LITERATURE REVIEW

In the following section, Hanover reviews the literature on improving the academic outcomes of students requiring additional supports in mathematics. Specifically, this section examines best practices in improving academic outcomes through instructional strategies, professional development, online and software-based instruction, bridge programs, and extended instruction.

Perhaps due to Algebra I’s role as a gateway course to all other secondary math courses, much of the literature on best practices in secondary math instruction for at-risk students focuses on Algebra I. For this reason, this report draws heavily from empirical research focused on best practices in teaching Algebra I to struggling students.

BACKGROUND

Research indicates that students who enter high school with below grade-level math skills are likely to stay behind. A 2014 report published by ACT Research and Policy, for example, examines multiple cohorts of students in Arkansas and Kentucky who took ACT Explore in Grade 8 and the ACT in Grades 11 or 12. The study separates students by their ACT Explore scores in mathematics into three categories:

- On-track (students who met the ACT College Readiness Benchmark),
- Off-track (students who missed the benchmark by one standard deviation or less),
- Far-off-track (students who missed the benchmark by more than one standard deviation).

On the following page, Figure 1.1 presents the percentage of students that meet the ACT College Readiness Benchmark as categorized by academic category (on-track, off-track, or far-off-track) and socio-economic status. Notably, low-income students are more likely to be off-track by Grade 11 or 12 regardless of their original track when compared with non-low-income students. However, students who enter high school behind grade level—regardless of socioeconomic status—are, on average, 50 percent more likely to stay behind when compared with their on-track peers.

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5 Ibid.
Although individual skills gaps in math will vary, students who struggle with math in secondary school may share several characteristics. The National Council of Teachers of Mathematics (NCTM) identifies several characteristics that are common to students with learning difficulties in math, regardless of motivation, prior instruction, and mathematical knowledge. Below, Figure 1.2 lists these characteristics.

**Figure 1.2: Characteristics of Students with Difficulties in Math**

- Demonstrate slow or inaccurate recall of basis arithmetic facts
- Answer problems impulsively, without inhibition
- Have difficulty representing mathematical concepts mentally
- Have poorly developed number sense
- Have difficulty keeping information in their working memory

Source: National Council of Teachers of Mathematics⁷

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⁶ Ibid.

http://www.nctm.org/uploadedFiles/Research_and_Advocacy/research_brief_and_clips/Student_with_Difficulties_Clip.pdf
INSTRUCTIONAL STRATEGIES

Researchers recommend that educators use a number of instructional strategies to positively affect low-achieving students’ math performance. A 2015 report by What Works Clearinghouse (WWC) published by the Institute of Education Sciences (IES) identifies three recommendations for improving algebra knowledge in middle and high school students. To identify these recommendations, the report considered over 2,800 studies from between 1993 and 2013 and found only 15 that met the WWC’s standards. Partially due to the small sample size, the report cautions that it only found minimal to moderate evidence for the efficacy of its recommendations. Figure 1.3 presents these three instructional strategies and the three steps involved in their implementation.

Figure 1.3: Recommended Instructional Strategies

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>STEP 1</th>
<th>STEP 2</th>
<th>STEP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use solved problems to engage students in analyzing algebraic reasoning and strategies.</strong></td>
<td>Have students discuss solved problem structures and solutions to make connections among strategies and reasoning.</td>
<td>Select solved problems that reflect the lesson’s instructional aim, including problems that illustrate common errors.</td>
<td>Use whole-class discussions, small-group work, and independent practice activities to introduce, elaborate on, and practice working with solved problems.</td>
</tr>
<tr>
<td><strong>Teach students to utilize the structure of algebraic representations.</strong></td>
<td>Promote the use of language that reflects mathematical structure.</td>
<td>Encourage students to use reflective questioning to notice structure as they solve problems.</td>
<td>Teach students that different algebraic representations can convey different information about an algebra problem.</td>
</tr>
<tr>
<td><strong>Teach students to intentionally choose from alternative algebraic strategies when solving problems.</strong></td>
<td>Teach students to recognize and generate strategies for solving problems.</td>
<td>Encourage students to articulate the reasoning behind their choice of strategy and the mathematical validity of their strategy when solving problems.</td>
<td>Have students evaluate and compare different strategies for solving problems.</td>
</tr>
</tbody>
</table>

Source: Institute of Education Sciences

A 2008 report published by the Center on Instruction (COI) also lists a series of recommendations for adjusting mathematics teaching strategies, several of which echo the recommendations published by the IES. While the report relies on a meta-analysis of studies on teaching mathematics to K-12 students with learning disabilities, the authors stress that

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9 Ibid.
the findings are applicable to students without learning disabilities who have trouble learning mathematics. The seven practices identified as effective are:

- **Teach students using explicit instruction on a regular basis.** “Explicit instruction... includes teaching components such as: clear modeling of the solution specific to the problem, thinking the specific steps aloud during modeling, presenting multiple examples of the problem and applying the solution to the problems, and providing immediate corrective feedback to the students on their accuracy.”

- **Teach students using multiple instructional examples.** “Teachers need to spend some time planning their instruction, particularly focusing on selecting and sequencing their instructional examples. The goal is to select a range of multiple examples of a problem type. The underlying intent is to expose students to many of the possible variations and at the same time highlighting the common but critical features of seemingly disparate problems.”

- **Have students verbalize decisions and solutions to a math problem.** Having students verbalize mathematical processes is an essential part of scaffolded instruction and may help anchor skills and strategies both behaviorally and mathematically. Verbalization helps to address impulsivity by forcing students to implement a solution step-by-step.

- **Teach students to visually represent the information in the math problem.** The systematic use of visuals (drawings, graphic representations) has positive benefits on students’ mathematic performance, especially when combined with explicit instruction. The study also finds that visuals are more effective when used by both the teacher and students.

- **Teach students to solve problems using multiple/heuristic strategies.** A heuristic strategy exemplifies a “generic approach for solving a problem” (e.g., “Read the problem. Highlight the key words. Solve the problems. Check your work.”).

- **Provide ongoing formative assessment data and feedback to teachers.** Teachers who constantly assess their students are better positioned to adjust instruction to meet students’ needs.

- **Provide peer-assisted instruction to students.** Peer and cross-age peer tutoring may be beneficial for at-risk students. For students with learning disabilities, cross-age tutoring is more effective because older tutors often have a firmer grasp of the subject and are subsequently more explicit instructors.

**Algebra-Specific Instructional Strategies**

In addition to the general instructional strategies discussed above, educators may also be interested in subject-specific instructional strategies for gateway courses such as Algebra I.

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11 Content adapted from: Ibid., pp. 5–10.
Bonnie Grossen, Ph. D., the director for the Center for Applied Research in Education (CARE), identifies additional instructional strategies for teaching students who struggle with algebra. Below, Figure 1.4 summarizes these strategies and places them into one of three categories: agenda and scheduling, instruction, and resources.

**Figure 1.4: Instructional Strategies by Type for Struggling Algebra Students**

<table>
<thead>
<tr>
<th>Agenda and Scheduling</th>
<th>Instruction</th>
<th>Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Small segments within a lesson-review of facts, development of algebra concepts, practice</td>
<td>• Use teacher-centered, explicit instruction when presenting new material in order to make strategies conspicuous to all students.</td>
<td>• Table lookups (not calculators) can be beneficial for students who have trouble with multiplication facts.</td>
</tr>
<tr>
<td>• Well-organized curriculum to facilitate continued practice and review</td>
<td>• Student-centered or small group, instruction is appropriate for applications and review, not for learning new material.</td>
<td>• A well-engineered textbook will help teachers make progress more efficiently and effectively. For example, if a school divides an algebra course over two years, the textbook needs to be adapted for extended instruction and learning.</td>
</tr>
<tr>
<td>• Review should be massed initially so that students have adequate practice time when learning a concept. After that, the review should be distributed, as well as cumulative.</td>
<td>• Scaffolding and/or guided prompting helps make strategies conspicuous.</td>
<td></td>
</tr>
</tbody>
</table>

Source: Doing What Works

**Effects of Instructional Strategies**

Best practice instructional strategies can have significant impacts on the learning outcomes of students who struggle in math. According to the COI, for example, a meta-analysis of eight studies indicates that the practice of student verbalization and reflective questioning recommended by WWC and COI can have a mean effect size of 1.04 on student math performance at a 99 percent confidence interval. Although the specific techniques used by researchers varied—some had students ask themselves questions, like, “Have I expanded the terms?” whereas others had students verbalize their questions, like, “What does the sign say? Okay. It’s addition,”—all required students to express problem-solving thoughts aloud. Likewise, a COI meta-analysis of four studies indicates that encouraging students to use multiple strategies to solve problems can have a mean effect size of 1.56 on student performance at a 99 percent confidence interval.

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Overall, the COI’s research on instructional strategies in math found that instructional strategies could have mean effect sizes ranging from 0.12 (within-class peer-assisted learning) to 1.56 (multiple heuristics), although confidence intervals varied. Below, Figure 1.5 summarizes the mean, median, and standard deviation of each instructional strategy.\textsuperscript{14}

### Figure 1.5: Impact of Instructional Strategies on Student Math Performance

<table>
<thead>
<tr>
<th>INSTRUCTIONAL STRATEGY</th>
<th>N</th>
<th>RANDOM EFFECTS MEAN</th>
<th>MEDIAN</th>
<th>STANDARD ERROR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit instruction</td>
<td>11</td>
<td>1.22***</td>
<td>1.39</td>
<td>0.23</td>
</tr>
<tr>
<td>Multiple heuristics</td>
<td>4</td>
<td>1.56***</td>
<td>1.62</td>
<td>0.46</td>
</tr>
<tr>
<td>Verbalizations</td>
<td>8</td>
<td>1.04***</td>
<td>1.42</td>
<td>0.32</td>
</tr>
<tr>
<td>Visuals for teacher and student</td>
<td>7</td>
<td>0.54***</td>
<td>0.67</td>
<td>0.16</td>
</tr>
<tr>
<td>Visuals for teacher only</td>
<td>5</td>
<td>0.41*</td>
<td>0.50</td>
<td>0.18</td>
</tr>
<tr>
<td>Visuals combined</td>
<td>12</td>
<td>0.47***</td>
<td>0.52</td>
<td>0.12</td>
</tr>
<tr>
<td>Range and sequence</td>
<td>9</td>
<td>0.82***</td>
<td>0.54</td>
<td>0.20</td>
</tr>
<tr>
<td>Teacher feedback</td>
<td>7</td>
<td>0.21*</td>
<td>0.19</td>
<td>0.10</td>
</tr>
<tr>
<td>Teacher feedback with recommendations</td>
<td>3</td>
<td>0.34~</td>
<td>0.40</td>
<td>0.21</td>
</tr>
<tr>
<td>Teacher feedback combined</td>
<td>10</td>
<td>0.23**</td>
<td>0.21</td>
<td>0.09</td>
</tr>
<tr>
<td>Student feedback</td>
<td>7</td>
<td>0.23**</td>
<td>0.17</td>
<td>0.09</td>
</tr>
<tr>
<td>Student feedback with goals</td>
<td>5</td>
<td>0.13</td>
<td>-0.17</td>
<td>0.30</td>
</tr>
<tr>
<td>Student feedback combined</td>
<td>12</td>
<td>0.21*</td>
<td>0.14</td>
<td>0.10</td>
</tr>
<tr>
<td>Cross-age tutoring</td>
<td>2</td>
<td>1.02***</td>
<td>0.95</td>
<td>0.23</td>
</tr>
<tr>
<td>Within class peer-assisted learning</td>
<td>6</td>
<td>0.12</td>
<td>0.17</td>
<td>0.11</td>
</tr>
</tbody>
</table>

*n refers to the number of effects; ~p<.10, *p<.05, ** p<.01, ***p<.001

Source: Center On Instruction\textsuperscript{15}

### PROFESSIONAL DEVELOPMENT

Numerous studies identify continual professional development as a necessary instructional support for effective math teachers and a key to high school reform. Accordingly, professional development is a common teacher support. Over the 2006-07 school year, the Council of the Great City Schools—a national organization representing the interests of urban public schools—found that almost 90 percent of surveyed urban districts offered both school-level professional development and voluntary district-wide professional development in mathematics.\textsuperscript{16} Of different professional development supports at the district and school level, curriculum and pacing guides represented the most common support, followed by new teacher mentoring and coaches/facilitators. The two least common supports were math specialists and teacher study groups.\textsuperscript{17}

**Overall, experts believe that professional development in math should focus on increasing subject matter knowledge and the ability to use specific instructional strategies.** Two

\textsuperscript{14} Ibid, p. 64.

\textsuperscript{15} Ibid.


studies published in 2008 by WestEd and the University of Texas at Austin highlight the importance of these strategies. The WestEd study notes both that, “effectiveness in teaching mathematics requires a combination of strong teaching skills and solid knowledge of the subject matter of mathematics,” and observes, “the students who are the most behind often encounter the least qualified teachers.”\(^{18}\) Although schools can address this problem by hiring new teachers, targeted professional development represents an easier and more effective way to improve teaching practices.\(^{19}\)

Both studies highlight the importance of building teacher capacity and identify the following strategies for improving teachers’ skills and math content knowledge:\(^{20}\)

- **Working and learning as a team:** Effective secondary math programs may have regular classroom observations and opportunities for feedback between teachers. A team-oriented culture supports new staff members and fosters ongoing learning opportunities.
- **Targeted professional development:** Effective secondary math programs may also provide individualized guidance and support for new teachers, subject-specific support, and ongoing learning opportunities for experienced teachers.

Professional development may also help convince reluctant teachers to adopt new teaching strategies. A 2008 case study published in the *Canadian Journal of Education*, for example, finds that teachers are often reluctant to adopt reform-based or student-centered teaching methodologies. After observing four classrooms of low-achieving math students in Grade 7-9, the researchers explained, “…teachers who we observed in their classroom settings were coping with students at-risk by falling back on familiar practices that afforded them the most control.” The study concludes that in addition to adopting early math interventions, educators may need to provide professional development focused on implementing student-centered or reform-based techniques, improving content knowledge, and recognizing the need for interventions.\(^{21}\)

**ALGEBRA-SPECIFIC PROFESSIONAL DEVELOPMENT**

In a series of research briefs published in 2014 by AIR as part of the *Promoting Student Success in Algebra* I project, AIR discusses professional development strategies to support student success in Algebra I. The brief stresses that, with the implementation of more rigorous standards in mathematics and the adoption of the Common Core State Standards for


\(^{19}\) Ibid., p. 3.


mathematics, teachers must accordingly create more rigorous learning environments.²² Although the brief is not targeted specifically towards teaching students with math deficits, the key findings and implications listed below in Figure 1.6 may be equally relevant for all algebra professional development programs.

### Figure 1.6: Key Findings and Implications for Program Developers and Administrators

<table>
<thead>
<tr>
<th>Strong Algebra Professional Development Programs</th>
<th>Program Developers and Administrators Should Consider…</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content of the Professional Development</strong></td>
<td></td>
</tr>
<tr>
<td>▪ Exhibit features of other high-quality professional development programs.</td>
<td>▪ Supporting professional development programs that are intensive, sustained, collaborative, and tightly linked to practice. This may require altering the supporting structures for such intensive, job-embedded professional development opportunities.</td>
</tr>
<tr>
<td>▪ Recognize that teachers may need support in understanding the mathematical concepts they are required to teach.</td>
<td>▪ Incorporating an explicit focus on developing teachers’ mathematical content knowledge. This focus may be particularly important for teachers at the elementary and middle school levels.</td>
</tr>
<tr>
<td>▪ Focus on strengthening students’ reasoning and conceptual understanding, including important prerequisite Algebra I topics.</td>
<td>▪ Identifying programs with strong supports for stimulating and supporting students’ reasoning and understanding, including topics that are important for students to master before they enter a formal Algebra I course. Programs should also ensure that the needs of special populations (e.g., students with special needs, English language learners, etc.) are addressed.</td>
</tr>
<tr>
<td>▪ Can be critical to the successful implementation of broader programs or initiatives designed to improve student success in algebra</td>
<td>▪ Supporting larger initiatives with a strong professional development component and collecting implementation data as the initiative is being rolled out.</td>
</tr>
<tr>
<td>▪ Are essential in supporting the implementation of technology designed to improve algebra instruction.</td>
<td>▪ Providing strong professional development support when introducing graphing calculators and/or software programs designed to improve algebra teaching and learning.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Delivery of the Professional Development</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>▪ Include explicit connections to the classroom, including the use of video or other technologies that support reflections on teacher practice.</td>
<td>▪ Investing in professional development programs that use classroom video as part of structured, concrete learning opportunities for algebra teachers.</td>
</tr>
<tr>
<td>▪ Provide structured opportunities for algebra teachers to collaborate with one another and with other experts through multiple mediums (e.g., online).</td>
<td>▪ Including online and face-to-face delivery mechanisms.</td>
</tr>
</tbody>
</table>

Source: American Institutes of Research²³

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²³ Figure taken verbatim from: Ibid., p. 9.
EFFECTS OF PROFESSIONAL DEVELOPMENT

Studies of professional development across multiple subject areas generally find that professional development can have a significant, positive impact on teachers’ instructional practice. A seminal 2001 study published in the *American Educational Research Journal*, for example, surveyed over 1,000 mathematics and science teachers to determine the extent to which professional development changed teachers’ self-perception of their instructional knowledge and skills. The survey found that activities with longer time spans, more content focus, and greater coherence had greater, significant effects on teacher knowledge and skills, “indicating that activities that give greater emphasis to content and are better connected to other reform efforts are more likely to produce” the desired effects.²⁴

However, some studies of professional development in math find that professional development has no significant impact on teachers’ instructional practice. A study of middle school professional development in mathematics released by the IES examined the delivery of a professional development program to 150 teachers across two years, and ultimately found that the program had no significant impact on teacher’s scores on a knowledge test. Moreover, student test scores had not improved significantly by the end of the professional development program.²⁵ Discussing the results, one researcher noted that the lack of significance “suggests that we do not yet know how to deliver professional development on a large scale in ways that can reliably improve student achievement.”²⁶

DIGITAL AND ONLINE LEARNING

Online and digital learning options may help struggling students catch up in higher-level math classes. These options include online credit recovery programs, as well as software-based intervention programs. However, limited quality research examines the efficacy of online options in comparison to traditional methods. While the outcomes of existing research support the online learning options, findings also stress the importance of complementary face-to-face instruction. The following sub-section briefly describes the characteristics and outcomes of online and software-based classes and programs.

ONLINE CREDIT RECOVERY CLASSES

Some districts may choose to offer struggling students the opportunity to recover math credits through online classes. A 2006 article published in *District Administration*, for example, profiles several districts that decided to let at-risk students enroll in online recovery programs after determining that their traditional practice—offering credit recovery programs

over the summer—was not adequately helping students. For example, one assistant superintendent of secondary instruction from Washington explains that, “If students enter ninth grade behind, the solution is [not] to slow them down or back them up. The solution is to catch them up.”

Online courses are available for two types of students: those who have failed Algebra I and those who are currently enrolled, but are at risk of failing. Proponents of this recovery option explain that online programs pre-test students on concepts and provide personalized instruction, which enables students to bypass material they have already learned or understand, and can lead to improved student outcomes.

Like proximate programs, online programs should follow best practices in general instruction, as well as best practices specific to online learning. Some researchers, for example, find that online programs with some face-to-face instruction—a model known as blended learning—may be a more successful approach to credit recovery than completely online programs. In a 2008 report highlighting successful online credit recovery programs in Texas, Florida, Michigan, and California, the North American Council for Online Learning (NACOL) observes a number of key lessons and best practices, which are outlined in Figure 1.7 below.

**Figure 1.7: Best Practices in Online Credit Recovery Programs**

- **Motivating students who have failed in the traditional classroom setting is crucial.**
  - The flexible and self-paced nature of online courses can motivate; these attributes can also remove the social stigma of credit recovery.

- **Online learning is particularly well suited for students recovering credit because it allows for individualized instruction.**
  - Online curriculum must be rigorous to ensure that students are learning the material, and not simply moving through the course.

- **Most online programs serving credit recovery and at-risk students—but not all—have a significant face-to-face component.**
  - The blended approach is important because it provides expanded student support and face-to-face contact.

Source: NACOL

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28 Ibid.
**Effects of Online Credit Recovery Classes**

General research on online classes (i.e., research on classes in any subject and field, across all age groups) indicates that online classes may be slightly more effective than in-person classes in improving student outcomes. A comprehensive meta-analysis of online learning conducted by the U.S. Department of Education’s Office of Planning, Evaluation, and Policy Development finds that overall, students in online learning courses perform “modestly better than those [students] receiving face-to-face instruction,” and that those increased gains are particularly noticeable among students participating in blended learning courses. However, the researchers caution readers against automatically applying the finding to all K-12 settings. Of the research they examined, only a small number of studies compared online and face-to-face learning for K-12 students. Consequently, most of the studies informing the meta-analysis came from other fields, such as higher education and professional training.  

In contrast, the most recent and extensive study on the efficacy of online classes in math for secondary students finds that face-to-face instruction is more effective than whole-class, online instruction for at-risk students in mathematics. This 2016 study, funded by the IES and conducted by AIR and the University of Chicago Consortium on School Research, examines the impact of online Algebra I credit recovery courses in 17 high school within the Chicago Public Schools (CPS) district over summer 2011 and summer 2012. A total of 1,224 students in Grade 9 who had failed Algebra I were randomly assigned into online or face-to-face second-semester Algebra I credit recovery courses. The online course included web-based software, in-class mentors who supervised the students, an online teacher who communicated individually with students via the learning management system, online chats, and online “whiteboard” demonstrations. The key findings from the study include:

- 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 percent vs. 76 percent).
- 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.

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32 Ibid., p. 4.

33 Bullets quoted verbatim from Ibid., p. 1.
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.

Notably, the most at-risk students may need online instruction combined with in-person instruction to succeed. Another key finding of the study concerns the mentors assigned to the various students taking the online course. Mentors either provided instructional support (these were often certified mathematics teachers) or did not provide instructional support. The study finds that students in online courses with instructionally supportive mentors recovered their credit at similar rates to students in face-to-face courses; this suggests that at-risk students may require additional instructional in-person support, at a proportion, according to the study, of 20 percent of course time or more.\(^{34}\) The study concludes that “continued improvement of online courses, particularly for highly at-risk students, is essential for fulfilling the great need for flexible alternatives for students whose futures depend on opportunities to get back on track in school.”\(^{35}\) The study also notes that the combination of online courses and mentors cost CPS more than face-to-face courses.\(^{36}\)

**Software-Based Intervention Programs**

Several districts have had success with supplementing traditional Algebra I courses with software-based intervention programs. Similarly to the online credit recovery classes, software-based and online intervention programs differentiate instruction for each student by identifying skills and knowledge gaps with pre-tests. The program then directs students to review missing concepts and allows them to bypass mastered material. Typically, students have time outside of their normal math class during which to use the software. Districts may choose to use software-based intervention programs due to their flexibility, individualization, accessibility, and affordability. For example, Aspen Valley High School in Colorado adopted Ascend Math Solution in an attempt to implement a program that would be accessible from multiple locations, allow students to test out of mastered material, provide teachers with data, and maintain the interest of students with learning disabilities. To allow students time to use the program, Aspen Valley High School places struggling students in a math lab where students have an extra period to use the school’s intervention program.\(^{37}\)

**Effects of Software-Based Intervention Programs**

A number of educational organizations issue reviews of software-based intervention programs intended to inform educators’ purchases. The National Center on Intensive Intervention (NCII), for example, provides an online “academic intervention tools chart” describing the evidence supporting mathematics interventions for elementary and middle

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\(^{36}\) Ibid., pp. 4–5.

school students. Likewise, state departments of education frequently publish guides to instructional interventions, like the Virginia Department of Education’s (VDOE) 2015 review of “instructional interventions that have proven to be successful with low-achieving students.” The IES’ “Find What Works!” tool—a widely publicized resource for assessing interventions across multiple subjects—also describes the improvement index and effectiveness rating of mathematics interventions; however, all programs with positive or potentially positive impacts currently identified by the IES for students in Grades 9–12 are full curricula, not supplementary interventions, and therefore do not apply to this area.

Below, Figure 1.8 lists the software and/or online supplemental math intervention programs that the VDOE describes as “proven to be successful” with low-achieving math students.

**Figure 1.8: VDOE-Approved Math Intervention Programs**

<table>
<thead>
<tr>
<th>INTERVENTION</th>
<th>MAIN FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Plus</td>
<td>• A Plus is an internet based system that allows teachers to choose appropriate instructional materials in mathematics for students at any level.</td>
</tr>
<tr>
<td>Cognitive Tutor</td>
<td>• Cognitive Tutor is a software program that features constant student monitoring, just-in-time help, and individualized skills tracking.</td>
</tr>
</tbody>
</table>

Source: VDOE

**BRIDGE PROGRAMS AND EXTENDED ALGEBRA COURSES**

**BRIDGE PROGRAMS**

Research shows that bridge programs can be effective in transitioning students in Grade 9 who are behind grade level in math into secondary math courses. Also referred to as “catch-up” courses or preparation programs, bridge programs address the learning gaps in Grade 9 students who are below grade level in math by offering these students a separate course before Algebra I. While bridge programs can occur in the first semester or year of high school, districts may also offer them in the summer. For example, Prince George’s County Public Schools in Maryland offered a month-long, 16-hour a week course to incoming Grade

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9 students in the summer preceding the 2015-16 school year. According to the district, this program “provide[s] students with an understanding of the number system, expressions, equations and functions to better prepare students to handle the rigor of their coursework in the upcoming school year.”

**Effects of Algebra I Bridge Programs**

The research on the effects of bridge programs for math is limited; however, one existing study suggests that bridge programs are effective in preparing students for high-level math courses. One 2006 report from the National High School Center on Talent Development High Schools (TDHS), examines a series of studies that focus on the challenge of improving low-performing urban and rural schools. The report finds that semester-long “catch-up” courses help prepare students for Algebra I. In a high school with 500 Grade 9 students, catch-up courses had an impact of 25 percentage points (or an increase of 125 students) on the percentage of students who would go on to earn a credit for Algebra I.

Prior research published in the *NASSP Bulletin* similarly indicates that bridge programs can support increased academic achievement in subjects including, but not limited to, math. The research discusses the case of Ingraham High School, which instituted bridge programs as a response to high withdrawal rates, absenteeism, and disciplinary violations among Grade 9 students. Although implementing the program was challenging, the school ultimately found that students participating in the bridge program had slightly higher grades, fewer disciplinary actions, and substantially lower withdrawal rates (5 percent of students withdrew in the year of the bridge program, compared to 22 percent of students in the year before the bridge program). The researchers concluded that bridge programs can be critical “to the academic and social success of ninth grade students.”

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43 “Algebra I and Biology Summer Bridge Programs for Rising 9th Graders.” Prince George’s County Public Schools, 2015. http://www1.pgcps.org/uploadedFiles/Schools_and_Centers/Middle_Schools/Hyattsville/Rotating_Stories/Algebra%20and%20Biology%20Bridge%20Fyler%20Final(1).pdf


45 The Talent Development High School model “is an education reform initiative that aims to improve the academic achievement of students in large, nonselective, comprehensive high schools...the approach encompasses five main features: small learning communities, organized around interdisciplinary teacher teams that share the same students and have common daily planning time; curricula leading to advanced English and mathematics coursework; academic extra-help sessions; staff professional development strategies; and parent- and community-involvement in activities that foster students’ career and college development.” For more, see: Kemple, J. and C. Herlihy. “The Talent Development High School Model.” MDRC, June 2004. http://www.mdrc.org/publication/talent-development-high-school-model


DOUBLE-DOSE ALGEBRA I

Double-dose Algebra I classes are a common support for at-risk students. According to a 2009 report by the Council of the Great City Schools, almost half of 53 surveyed urban districts listed double periods of math instruction as the most commonly used support for struggling students.\textsuperscript{48} Double-period Algebra I courses typically consist of an extended Algebra I class or a normal class combined with an additional support class.

EFFECTS OF DOUBLE-DOSE ALGEBRA

Although a number of educators identify double-dose Algebra I classes as an effective strategy for catching up underprepared mathematics learners, limited studies examine the impact of this strategy on student outcomes.\textsuperscript{49} However, the existing literature is positive. The most extensive and highest quality study of the impacts of the double-dose of Algebra I method was conducted in Chicago Public Schools (CPS), which adopted the double-dose strategy in 2003. A 2010 report published by the Consortium on Chicago School Research (CCSR) using CPS data finds that “the double-dose strategy, when accompanied by additional supports for teachers, has significant promise for improving academic skills of all students.”\textsuperscript{50}

In 1997, CPS started requiring that students enroll in Algebra I in Grade 9 and then continue to take Geometry and Algebra II in the following two years. CPS instituted the double-dose policy for Algebra I in response to the high number of students failing Algebra I (roughly 25 percent of incoming freshmen). Starting in 2003, all students who tested below the national median on a math test in Grade 8 enrolled in a regular algebra class and an additional algebra support class for all of Grade 9. To support these double-dose classes, the district provided teachers with professional development workshops on teaching extended instruction classes; teachers also received adapted curriculum materials.\textsuperscript{51}

The district’s three basic guidelines for implementing double-dose classes were:\textsuperscript{52}

- Double-dose algebra students should have the same teacher in algebra and algebra support;
- The courses should be offered sequentially; and
- Students should take their algebra support course with the same students who were in their regular algebra courses.

Ultimately, the double-dose classes had mixed effects on student outcomes. Students test scores in math improved, yet the policy also contributed to higher failure rates and lower

\textsuperscript{51} Ibid., p. 4.
\textsuperscript{52} Bullets quoted verbatim from: Ibid., p. 5.
grades for students enrolled in regular single-period Algebra I courses.\textsuperscript{53} Below, Figure 1.9 presents the report’s key findings and their explanations.

![Figure 1.9: Key Findings of the Double-Dose Algebra Policy in Chicago Public Schools](image)

<table>
<thead>
<tr>
<th>KEY FINDING</th>
<th>EXPLANATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pros</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Low-skill and high-skill students improved their math skills | - Low-skill students in the double-dose algebra classes benefited from increase instruction time and more interactive pedagogy. Academic demand also increased for targeted students.  
- High-skill students in the single-period algebra classes benefited from a more homogenous peer group, allowing teachers to cover more difficult material than in the past. There were also less behavioral and attendance problems which contributed to the improved learning environment. |
| Students with the weakest entering math skills benefitted least from the double-dose policy. | - Many of the very low-skill students had identified learning disabilities, yet the policy did not specifically address how schools should accommodate their needs in double-dose algebra classes.  
- In many schools, students with learning disabilities went from small, homogeneous classes to larger double-period algebra courses. |
| **Cons** |             |
| For low-skill students, Algebra I failure rates did not decrease | - For students in the double-dose algebra classes, CCSR finds that even though students were learning more algebra than before, teachers raised their expectations, making the course more difficult to pass.  
- Furthermore, the concentration of peers with behavioral and attendance problems had an adverse effect on some students’ attendance and effort, making them more likely to fail; this offset the benefits of improved learning among other students. |
| For higher-skill students, Algebra I failure rates increased and average grades declined | - Faced with more challenging material and stronger peers, students with slightly above-average skills were now the weaker students in their classes and their course performance suffered accordingly.  
- Other work has shown that teachers tend to give lower grades to students who are not performing well in comparison with stronger students in the same class. |

Source: Consortium on Chicago School Research\textsuperscript{54}

The report concludes that reformers and policymakers should note that double-dose classes are more likely to succeed when accompanied by “significant instructional supports, including extended instructional time, curricular resources, and professional development on instructional practice.”\textsuperscript{55}

**LONG TERM EFFECTS**

\textsuperscript{53} Ibid., p. 1.  
\textsuperscript{54} Figure text adapted from: Ibid., pp. 1–10.  
\textsuperscript{55} Ibid., p. 7.
Double-dose algebra may have positive effects on longer term outcomes such as high school graduation rates, college entrance exam scores, and college enrollment rates. A more recent study published in *Education Next* in 2013 examines longer-term outcomes of CPS’ double-dose algebra policy. The study compares advanced math course work and performance, ACT scores, high-school graduation rates, and college enrollment rates of students just below and just above the double-dose qualification threshold. Figure 1.10 presents these long-term effects separated by academic performance, performance on standardized tests, and graduation and college outcomes.

**Figure 1.10: Long-term Effects of the Double-Dose Algebra Policy in Chicago Public Schools**

<table>
<thead>
<tr>
<th>EFFECT CATEGORY</th>
<th>DETAILS</th>
</tr>
</thead>
</table>
| **Effects on Long-term Academic Performance** | ▪ Double-dosing had an immediate impact on student performance in algebra, increasing the proportion of students earning at least a B by 9.4 percentage points, or more than 65 percent.  
▪ It did not have a significant impact on passing rates in 9th-grade algebra, however, or in geometry (usually taken the next year).  
▪ Double-dosed students were, however, substantially more likely to pass trigonometry, a course typically taken in 11th grade.  
▪ The mean GPA across all math courses taken after freshman year increased by 0.14 grade points on a 4.0 scale. |
| **Effects on Standardized Testing** | ▪ The study does not find consistent evidence of impacts on student performance on the preliminary ACT (called PLAN) exam taken in the fall of 10th grade.  
▪ It does find impacts on the 11th-grade PLAN (see Figure 1). On that exam, double-dosing was found to increase algebra scores by 0.15 standard deviations and overall math scores by 0.16 standard deviations.  
▪ a nearly identical effect is seen on the math portion of the ACT (taken in the spring of 11th grade), with double-dose algebra raising scores by 0.15 standard deviations on an exam used by many colleges as part of the admissions process. This is equivalent to closing roughly 15 percent of the black-white gap in ACT scores. |
| **Effects on Graduation and College** | ▪ Double-dosing increased four- and five-year high school graduation rates by 8.7 and 7.9 percentage points, respectively, a 17 percent improvement.  
▪ Double-dosed students were 8.6 percentage points more likely to enroll in college within five years of starting high school, a nearly 30 percent increase over the base college enrollment rate of 29 percent. Nearly all of this increase comes from enrollment in two-year colleges, with more than half of that resulting from part-time enrollment in such colleges. |

Source: *Education Next*[^56]

Students with weaker reading skills particularly benefited from the double-dose strategy. These students performed higher on the verbal portion of the ACT, were more likely to pass chemistry classes taken in Grades 10 or 11, and earned high GPAs throughout high school.\textsuperscript{57}

**TWO YEAR ALGEBRA**

Two-year Algebra I classes cover the concepts covered in one year of algebra in two years. Some educators believe that extending algebra learning time in this way “allows students to spend more time on each concept” and “complete hands-on labs and activities.”\textsuperscript{58}

**EFFECTS OF TWO-YEAR ALGEBRA I**

While many districts, especially those with larger high schools, offer two-year Algebra I courses for struggling students, few studies examine the effects of such offerings on student achievement.\textsuperscript{59} However, the informal scholarly consensus suggests that two-year Algebra I courses are typically detrimental to low-achieving math students. Although a 2013 report published by the University of Illinois at Chicago states that additional instructional time may significantly benefit underprepared learners, the report clarifies that spreading Algebra I over two years should be avoided because “it delays students completion of Algebra I and puts students at higher risk of not completing the required high school mathematics sequence.”\textsuperscript{60}

Similarly, Bonnie Grossen of the Center for Applied Research in Education notes that two-year programs are often ineffective because the curriculum and teaching strategies are not adapted to the particular set of students; rather, the course proceeds as it normally would, but requires twice the amount of time.\textsuperscript{61}

\textsuperscript{57} Ibid.
SECTION II: SCHOOL PROGRAM PROFILES

This section profiles four districts with math programs focused on raising underprepared secondary students’ achievement and promoting their success in Algebra I and subsequent higher level math courses. Figure 2.1 lists these schools and the relevant demographics.

Figure 2.1: Demographics of Profiled Programs

<table>
<thead>
<tr>
<th>SCHOOL (OR PROGRAM)</th>
<th>DISTRICT</th>
<th>STATE</th>
<th>ENROLLMENT</th>
<th>% MINORITY</th>
<th>% FREE OR REDUCED-PRICE LUNCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant High School</td>
<td>Portland Public Schools</td>
<td>OR</td>
<td>1,485</td>
<td>34%</td>
<td>23%</td>
</tr>
<tr>
<td>Granby High School</td>
<td>Norfolk Public Schools</td>
<td>VA</td>
<td>1,988</td>
<td>71%</td>
<td>37%</td>
</tr>
<tr>
<td>North Plainfield High School</td>
<td>North Plainfield School District</td>
<td>NJ</td>
<td>1,489</td>
<td>88%</td>
<td>66%</td>
</tr>
<tr>
<td>Summer Bridge Program</td>
<td>Chicago Public Schools</td>
<td>IL</td>
<td>1,743</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Source: National Center for Education Statistics (Statistics from 2013-14 school year)

GRANT HIGH SCHOOL – PORTLAND PUBLIC SCHOOLS

In Portland Public Schools, Grant High School offers an intensive mathematics program that includes double-dose classes for underprepared students. Notably, the school was profiled in a 2008 University of Texas at Austin report on innovations in improving secondary mathematics for its success in strengthening teaching and learning. Given this success, the following profile describes the program and details its impact on student outcomes.

PROGRAM DESCRIPTION

In the early 2000s, teachers at Grant High School observed that a large percentage of students were arriving underprepared for Algebra I in Grade 9. Moreover, roughly two-thirds of unprepared students were minorities. Likewise, students in high-level secondary math courses like Precalculus were predominately white. To promote a more equitable math program with equal opportunities for Black, Hispanic, and Asian-American students, teachers decided to provide double periods of math for underprepared students during their first two years of high school. Over this two-year period, participating students would complete three math courses: Pre-Algebra, Algebra I, and Geometry.

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Leaders believed that by doing so, students would be able to catch up with their peers and take Algebra II by their junior year of high school. The program began in the 2002-03 school year with four assigned teachers. While the initial plan was for students to have the same teacher for double periods for the full two years, only three teachers were needed the following year due to student attrition; as a result, some students switched teachers. After the first three weeks of the year, no students were allowed to transfer into the program.65

**Teachers and Curriculum**

According to the University of Texas at Austin report, the four teachers assigned to the program were highly experienced. As the report describes, the teachers were:66

...trained in complex instruction, meaning they could develop and use curricula for students with various abilities using group-work activities and could use instructional strategies that required students to use cooperative norms and specific roles to manage their own groups.

Additionally, the teachers believed in the efficacy of the intensive program and worked closely as a team. They were also communicative with students’ parents—who were generally supportive—and would call when students were absent from class.

With regard to curriculum, the teachers began by using materials from Connected Mathematics and Integrated Mathematics I and II. They later switched to the College Preparatory Mathematics curriculum when Portland Public Schools adopted new textbooks. To supplement the academic curriculum and provide the students with role models, the school also invited people of color working in different fields to talk with students about navigating the school system and post-secondary opportunities. As the report describes, this “helped model success for students—showing what people did to succeed, not just in mathematics, but also in school and life in general.”67

**Scheduling**

The school created freshmen academies for all entering freshmen the same year that the two-year intensive mathematics program began. Within these academies, students were grouped into learning communities and shared a common set of classes. The University of Texas at Austin report notes that these communities created a “culture of learning and support that students could feel in their two periods of math.” 68 To further promote this sense of communal learning, the principal adjusted the schedule so that the teachers of the double period classes had common daily planning time.

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65 Ibid., pp. 2–3.
66 Ibid., p. 3.
68 Ibid.
PROGRAM RESULTS

Overall, available data suggest that the double-dose program led to an increase in the percentage of students identified as at-risk in math enrolling in Algebra II during high school. Figure 2.2 presents the Algebra II enrollment rates for Grant High School from the year the program began (2002-03) to the year the first cohort of students would have been ready for Algebra II (2004-05). As demonstrated in this figure, the percentage of Hispanic, Black, and economically disadvantaged students enrolled in Algebra II increased in 2004-05, which the report attributes to the success of the two-year intensive program.

**Figure 2.2: Grant High School Algebra II Enrollment Rates**

<table>
<thead>
<tr>
<th>DEMOGRAPHIC GROUP</th>
<th>2002-03</th>
<th>2003-04</th>
<th>2004-05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asian American</td>
<td>5.6%</td>
<td>6.3%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Black</td>
<td>8.9%</td>
<td>12.3%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2.3%</td>
<td>2.4%</td>
<td>4.3%</td>
</tr>
<tr>
<td>White</td>
<td>83.2%</td>
<td>80.6%</td>
<td>72.7%</td>
</tr>
<tr>
<td>Economically Disadvantaged</td>
<td>3.3%</td>
<td>n/a</td>
<td>20.9%</td>
</tr>
</tbody>
</table>

Source: University of Texas at Austin

In addition, the results of surveys administered at the end of the first year of the program were generally positive: of the students participating in the program, 67 percent were confident that they could find the solution to a word problem, 74 percent were confident they could solve a multiple-choice mathematics item, and 87.5 percent of students were planning to complete high school and pursue post-secondary education.

However, the outcomes data presented in the report have several limitations. The report does not, for example, compare the standardized test performance, graduation rates, or course-taking histories of students in the program with that of students outside the program. Also problematic is that while 66.7 percent of students in the two-year intensive mathematics program completed the first year of the program, only 62 of the original 126 student enrollments at the beginning of the second year, due to students changing high schools, dropping out, and transferring to other math courses.

GRANBY HIGH SCHOOL – NORFOLK PUBLIC SCHOOLS

In Norfolk Public Schools, Granby High School offers students several supports identified by WestEd in 2008 as “elements of a strong math program that serves all students.” These supports include high-level math courses, continual professional development for teachers, and data-driven instruction. The following profile details how Granby High School used professional development to improve student outcomes in math.

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69 Ibid., p. 4.
70 Ibid., pp. 4–6.
**PROGRAM DESCRIPTION**

In the 1997-97 school year, fewer than one in five Granby High School students passed Algebra I, and only one in four students passed Algebra II. Low academic achievement and frequent behavioral problems consistent issues at the school. As such, staff recognized that the school needed to reform its approach to math instruction to better prepare students for college and careers. As the school crafted this reform, the district simultaneously overhauled the system-wide approach to professional development, which WestEd points to as “playing a significant part” in the school’s success in reforming the math program. The principal of Granby High School, Ted Daughtrey, likewise attributes much of the school’s success to the increased emphasis on professional development. According to Daughtrey, three elements were critical to the reform: working and learning together as a team, providing teachers with varied and appropriate learning opportunities, and ensuring that professional development impacts student achievement.72

**WORKING AND LEARNING TOGETHER AS A TEAM**

As part of the reform effort, professional development at Granby High School became increasingly collaborative and team-oriented. Instead of training alone, teachers participated in professional development with their colleagues. This shared participation helped foster an atmosphere of continual on-the-job learning, and focused on subjects such as understanding student performance data and collecting observation-based feedback.

**PROVIDING TEACHERS WITH VARIED AND APPROPRIATE LEARNING OPPORTUNITIES**

Granby High School personalized the professional development program to help ensure that offerings were tailored to the needs of individual teachers. These offerings include:73

- **New teacher guidance and support**: Teachers who are new to Granby participate in a range of learning opportunities designed to orient them to the school, district, the profession, and to bolster their subject matter knowledge. New teachers take part in a three-year teacher induction program that promotes their effectiveness and helps keep them in their positions... They work closely with a coach who observes their teaching and gives detailed feedback and guidance.

- **Subject-specific support teams**: In addition to meeting as a department, teachers meet in subject-specific teams that work together to plan units, develop lesson plans, and evaluate student data. Teams discuss student needs and develop extra academic supports as needed. Granby teachers report knowing each other’s work intimately and are therefore able to hold each other accountable for teaching all of their students to a high standard.

- **Ongoing learning opportunities for experienced teachers**: Granby teachers also have access to a range of professional development experiences that complement what they are learning from departmental colleagues. Professional development leaders

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72 Ibid., p. 16.
73 Bullets quoted verbatim from: Ibid., p. 18.
target learning opportunities to the needs of the students and to the individual staff members in need of the support.

The professional development also helped increase support for the reform effort among veteran teachers. The WestEd report cites the example of an Algebra teacher with a reputation as one of the toughest teachers with a “teacher-centric” instructional style. While this teacher was initially resistant to professional development, after several workshops and meetings tailored to their needs, the teacher began to experiment with alternative instructional strategies. As a result, their classes’ grades and pass rates increased.  

**Program Results**

The goal of the professional development program was increased student achievement in math, and in this respect, it succeeded. In 1997-98, less than one in five Granby High School students passed Algebra I and only one in four passed Algebra II. A decade later in 2006-2007, 84 percent and 90 percent of students were passing Algebra I and II, respectively. In that same year, 90 percent of Granby students passed Virginia’s state end-of-course test in Algebra II. While the WestEd report notes that these changes took place within the context of a large reform initiative involving multiple efforts and programs, Granby High School attributes much of its students’ math gains to the changes in its professional development program. Figure 2.3 presents the performance gains in Algebra I, Geometry, and Algebra II as measured by the passing standards for end-of-course tests.

![Figure 2.3: Granby High School Math End-of-Course Test Performance Data](image)

Source: WestEd

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74 Bullets quoted verbatim from: Ibid.
75 Ibid., p. 4.
76 Ibid., p. 15.
SUMMER BRIDGE PROGRAM – CHICAGO PUBLIC SCHOOLS

This report has already discussed CPS’ online credit recovery and double-dose algebra programs in Section I. Accordingly, this profile will focus on a third aspect of CPS’s mathematics program for underachieving students: a four-week summer bridge program for incoming Grade 9 students in CPS high schools that focuses on mathematics and literacy. The 2008 University of Texas at Austin report identified this program as showing promise in strengthening CPS’ mathematics teaching and learning.

PROGRAM DESCRIPTION

Originally called “Step Up to High School” but now referred to simply as the Summer Bridge Program, CPS’s bridge program aims to help students make the social and academic transition from middle to high school. According to the University of Texas at Austin, the program is modeled around the following principles:

- Placing special emphasis on students’ freshman year while providing differentiated support for students.
- Helping develop a supportive academic network, by recognizing the negative effects of social isolation on academic success.
- Increasing teacher capacity in understanding ethnic- and gender-based differences and providing better interactions between teachers and students.
- Providing and promoting interactive, hands-on, real-life applications of the content.

CPS began the bridge program with 1,661 students in the summer of 2003. Eligible students had graduated from Grade 8 from CPS, were not required to attend another summer program, and scored between the 35th and 49th percentile in reading or math on either the Iowa Test of Basic Skills assessment in Grade 7 or ACT’s Explore assessment in Grade 8. CPS focused on this group of students because they were likely to be overlooked by other programs, which automatically accepted students scoring in lower percentiles.

The CPS bridge program lasts for four weeks; students attend five days a week for four hours each day. The daily schedule consists of three parts: 90 minutes of instruction in both math and literacy and 45 minutes of guidance with a school counselor.

MATHEMATICS

The 90 minute math classes focus “on learning conceptually and modeling practices that mathematicians use (thinking, reasoning, collaborating, presenting findings to peers, etc.)”

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80 Ibid.
81 Ibid.

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engaging in discourse/debate) and learning what will be expected of them in high school mathematics courses."  

Coursework was originally drawn from an algebra unit from Connected Mathematics, but was later replaced by Mathematics in Context. Instructional strategies include discussions, small-group problem-solving, in-class presentations of material, and manipulative and physical modeling. The University of Texas at Austin report states that such instructional strategies allow “students to visualize the concept concretely.”

Additionally, CPS assigned students to the same teachers they would have the following school year in their high school math course whenever possible.

**PROFESSIONAL DEVELOPMENT**

Teachers in the CPS bridge program receive five professional development sessions before the program starts and an additional five two-hour sessions during the program. These sessions aim to “develop a strong professional community of teachers focusing on freshman instruction.”

Teachers receive materials from program facilitators that include the research behind the program and instructional materials and strategies. In professional development sessions, teachers discuss assigned readings and connect them to their classes and students. Teachers have the option to videotape their classes for group professional feedback and are also allowed to experiment with alternative teaching strategies and curricula that they have not yet used in their normal school year classes.

**PROGRAM RESULTS**

Extensive longitudinal data are not available on the students who participated in the CPS bridge program throughout their high school career. However, for the two cohorts of students that attended the bridge program before the 2004-05 and 2005-06 school years, data reveal that students who attended the bridge program were less likely to fail Algebra I (in both single and double period courses) than students who did not attend the program. This is demonstrated in Figure 2.4.

### Figure 2.4: Percentage of CPS Students Failing Algebra I

<table>
<thead>
<tr>
<th>Semester</th>
<th>Single Period Algebra I</th>
<th>Double Period Algebra I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bridge Students</td>
<td>Non-Bridge Students</td>
</tr>
<tr>
<td>Fall 2004-05</td>
<td>18.2%</td>
<td>19.9%</td>
</tr>
<tr>
<td>Spring 2004-05</td>
<td>25.6%</td>
<td>27.4%</td>
</tr>
<tr>
<td>Fall 2005-06</td>
<td>15.1%</td>
<td>29.4%</td>
</tr>
<tr>
<td>Spring 2005-06</td>
<td>24.3%</td>
<td>36.0%</td>
</tr>
</tbody>
</table>

Source: The University of Texas at Austin

Additionally, post-freshman year drop-out rates were lower for bridge program students in comparison to students with similar assessment scores that did not attend the bridge

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82 Ibid., pp. 3–4.
83 Ibid., p. 4.
84 Ibid., p. 3.
85 Ibid., p. 7.
program (in 2004-05, 4.0 percent vs. 6.9 percent, and in 2005-06, 2.4 percent vs 6.7 percent). The program was also popular among district stakeholders. Surveyed teachers viewed the program positively and felt that the students were learning. Students also gave positive feedback about the program: 82 percent reported that they felt the program improved their mathematics skills, and 96 percent of students reported they knew what to do in order to be successful in high school.86

The CPS summer bridge program has since expanded to offer intensive instruction in reading and mathematics for students leaving Grades 3, 6, and 8. The program targets students who do not meet the minimum promotion criteria and provides them with additional time and instruction so that they may continue to the next grade, and uses an online curriculum.87 According to CPS, benefits of the existing program include a narrow achievement gap, increased student promotion rates, and increased achievement on standardized tests:88

NORTH PLAINFIELD HIGH SCHOOL – NORTH PLAINFIELD SCHOOL DISTRICT

In North Plainfield School District in New Jersey, North Plainfield High School focuses on making math accessible for all students. At the secondary level, this focus on accessibility underlies the implementation of double periods of math instruction, software-based learning support programs, and college prep and honors options for advanced math courses.89

PROGRAM DESCRIPTION

To help students entering Grade 9 with poor math skills, North Plainfield High School instituted a double period pre-Algebra course called, “Math Knowledge and Numeracy.” This program aims to fill students’ knowledge gaps and prepare them to take Algebra I. According to the district, the program affords students the “gift of time’ to explore difficult and challenging concepts in greater depth.” Additionally, teachers in this program receive focused professional development and incorporate technology (e.g., interactive white boards, graphing calculators, and computer software) into instruction.

Perceived benefits of the program include:90

- The additional time will also allow teachers to more readily accommodate students’ learning needs through differentiated instruction, small group work and individual attention.
- Frequent assessment will ensure that teachers know where students are achieving proficiency, and where they will need support.
- Support for classified students and those who are English Language Learners will be a critical component of this program.

86 Ibid.
88 Bullets quoted verbatim from: Ibid.
89 “Mathematics / Overview.” http://www.nplainfield.org/Page/368
90 Bullets quoted verbatim from: Ibid.
Due to the popularity of the double period pre-Algebra program, the district also added a double period Algebra I course called “Algebra I Knowledge and Application.” This course covers the same content as the standard Algebra I single period course; however, students in the double period section benefit from additional instructional time and have access to a textbook and software combination program through Carnegie Learning.  

**PROGRAM RESULTS**

Although the district website refers to the double period courses as a success, the district does not offer any comparable data to help readers confirm this statement or determine the magnitude of success. The latest data collected by the state of New Jersey indicate that roughly one-quarter of students at the school meet grade-level math expectations.

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91 Ibid.

PROJECT EVALUATION FORM

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