Math Facts Practice Pays Off

Introduction

This large-scale, peer-reviewed study examined how initial math achievement levels influenced the path to math fact automaticity as well as the relationship between attainment of automaticity and gains in general math achievement. Although most students did not meet grade-level recommendations for addition and subtraction mastery identified by various standards-setting organizations, such as the National Mathematics Advisory Panel and the Common Core State Standards Initiative, those who did were likely to achieve superior gains in math achievement, controlling for pretest scores (see figure 1).

Figure 1. Students meeting Renaissance MathFacts in a Flash® operational benchmarks make extraordinary gains

Note: Normal curve equivalents (NCEs) are a way of representing percentile scores so they can be accurately averaged and compared with each other. Because NCEs are derived from percentiles, they measure growth in comparison to national norms. Positive NCE gains mean student achievement grew at a faster rate than national averages. An NCE gain of zero represents the national average.

Main findings

• Most students did not meet grade-level standards for addition and subtraction; those who did were likely to achieve superior gains in math achievement.

• Spending more time working in MathFacts in a Flash was associated with general math gains, particularly for low achieving students.

• Low-achieving students needed more time to reach automaticity, but when they did they experienced the same math gains as higher achieving students. Though it takes more time and effort for low-achieving students to master math facts, doing so was associated with positive gains.

Race/Ethnicity

1 Race/Ethnicity data were only available for 39% of students in the study.

Summarized from

Study description

MathFacts in a Flash, which is highly rated for progress-monitoring mastery measurement by both the National Center on Intensive Intervention (2014) and the National Center on Response to Intervention (2011), is a computerized assessment that uses timed trials and multiple-choice questions to assess both the accuracy and retrieval speeds of math facts.

During the 2009–2010 school year, more than 400,000 K–12 students across the country used this program through Renaissance’s Learning’s online service, making the results of their practice and testing available for analysis. To examine critical math-skill development for low- and higher-achieving students, this study examined MathFacts in a Flash data for 89,159 students from all 50 states in grades 1–3 who had pre- and posttest Star Math scores.2

The students studied were placed in math performance categories based on their percentile rank (PR) scores from the Star Math pretest (see figure 2). Low-achieving students were placed in one of two categories: 23% of students were considered severely deficient (PR 1–15) while 15% were at risk (PR 16–30). The other 62% of students were higher achieving and thus placed in the low-risk category (PR 31–99).

Figure 2. Math performance categories for study sample (N = 89,159; grades 1–3)

Mastering basic math skills at appropriate ages is important for establishing a solid foundation for future math education. MathFacts in a Flash considers a fact “mastered” if the student demonstrates automaticity by meeting speed and accuracy criteria. The National Mathematics Advisory Panel (2008) recommends that students demonstrate automaticity in addition and subtraction facts by third grade; 3 students who do not may be even less likely to master math facts in the future.

The study addressed three questions about early development of critical math skills for low-achieving (those in the severely deficient and at-risk categories) and higher achieving (or low-risk) students:

1. To what extent have students achieved math fact automaticity goals outlined by standards-setting organizations, and are there benefits in terms of general math achievement gains for students who reached these goals?

2. To what extent did the path to automaticity vary for low- and high-achieving students (in terms of overall likelihood of obtaining mastery, grade placement at time of mastery, number of attempts required, retrieval speed, and maintenance over time)?

3. How did differences in initial student achievement affect relations between math fact automaticity and gains in general math achievement?

“Teachers can feel confident that using tools such as [MathFacts in a Flash] to build math fact automaticity can contribute significantly to improved general mathematics achievement” (p. 91).

2 The Star Math assessment is a standardized computer-adaptive measure of general mathematics achievement.

3 In the MathFacts in a Flash program, the benchmark for addition is slightly earlier—mastery by end of grade 2.
Results

As shown in table 1, by the end of the year, the percentage of students in the sample meeting recommended operational goals for addition and subtraction was low. By the end of grade 2, only 36% of students had mastered addition (growing to 50% by the end of grade 3) while only 26% of students had mastered subtraction by the end of grade 3.

Table 1. Percentage of sample meeting MathFacts in a Flash® operational benchmarks for addition subtraction

<table>
<thead>
<tr>
<th>Grade</th>
<th>Percent of Student Mastering</th>
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<tbody>
<tr>
<td></td>
<td>Addition (Target Grade 2)</td>
</tr>
<tr>
<td>1</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>36%</td>
</tr>
<tr>
<td>3</td>
<td>50%</td>
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For students who met these benchmarks, study results showed that mastery was associated with statistically significant improvement in general math performance across the school year. Low-risk students were most likely to meet math fact automaticity goals outlined by standards-setting organizations, at-risk students were less likely, and severely deficient students were least likely. Mastering addition led to statistically significant Star Math gains for all students; however, addition mastery tended to lead to the greatest normal curve equivalent (NCE) gains for severely deficient students, followed by at-risk students, and then by low-risk students. Similarly, subtraction mastery led to statistically significant NCE gains for all student categories, but led to the greatest gains for severely deficient students, followed by fewer gains for at-risk students, with the fewest gains for low-risk students.

Analysis revealed that the higher-achieving students mastered more MathFacts in a Flash levels, and reached higher levels, than students in the low-achieving categories. Relative to the higher-achieving students in the low-risk category, the students in the two low-achieving groups required more attempts to establish automaticity, achieved automaticity later, and demonstrated slower retrieval speeds.

Overall, low-achieving students were less likely to demonstrate fluent retrieval of math facts, but those who did experienced particularly large gains in general math achievement. In addition, increased MathFacts in a Flash use was more beneficial for low-achieving students than for higher-achieving students.

Burns, Kanive, and DeGrande (2012) had similar findings. This study investigated the extent to which regular practice with MathFacts in a Flash (i.e., 3–5 sessions per week for 8 to 15 weeks) was beneficial for low-achieving students in grades 3 and 4. Relative to a control group that did not use MathFacts in a Flash and controlling for pretest, the treatment group experienced greater rates of pre–post growth (effect sizes of $d = 0.34$ and $d = 0.44$ in grades 3 and 4, respectively).
As stated in the Stickney, Sharp, and Kenyon (2012) study, "Teachers can feel confident that using tools such as [MathFacts in a Flash] to build math fact automaticity can contribute significantly to improved general mathematics achievement" (p. 91). Regardless of math performance category, using this program to master addition or subtraction operations led to significantly higher gains than not mastering the operations (see figure 1, first page). In some cases, gains for students who mastered the operations were double those for students who did not.

Conclusion

MathFacts in a Flash is a useful tool that enables educators to help all students master math facts and build foundational fluency as required by college- and career-readiness standards, such as the Common Core State Standards, and other standard-setting organizations. Results suggested that math facts practice pays off, especially for low-achieving students, which may provide a means for breaking the typical cycle of falling further behind in mathematics each year.

Though students who were severely deficient and at-risk may have needed more time to master MathFacts in a Flash levels than low-risk students, they experienced the same math achievement gains once they mastered them. Although it takes more time and effort for low-achieving students to achieve automaticity, doing so was associated with positive gains regardless of student-achievement category.

The results emphasized the importance of building in extra time for practice. Time spent practicing with MathFacts in a Flash was positively related to gains in general math achievement, which was especially important for low-achieving students.

References


