DMT INSIGHTS

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Math Success by DMTI

BEYOND DRILL AND PRACTICE: BUILDING MULTIPLICATION FACT FLUENCY

What we learned from comparing strategy-based instruction with traditional drill and practice

Abstract

What happens when students practice multiplication facts by reasoning from known relationships rather than relying primarily on repeated drill? In this study, third- through fifth-grade students received either traditional drill-based instruction or instruction that emphasized flexible strategies and multiple representations. Averaged across the three grades, both groups gained, and students in the strategy-based group made substantially greater gains in multiplication fact fluency. The findings suggest that practice matters, but what students can reason from as they practice matters too.

Introduction

Students need to access multiplication facts efficiently. The question is how we help them get there.

Is repeated drill enough, or does fluency develop differently when students can build an unknown fact from relationships they already know? That question guided this study (Brendefur et al., 2015).

The comparison was not practice versus no practice. Both groups practiced multiplication facts. The difference was in the instruction surrounding that practice. Students in the strategy-based condition learned to use known facts, mathematical relationships, and representations to derive facts they did not yet recall efficiently.

> **Key Idea • The comparison was not practice versus no practice. Both groups practiced. The difference was in the instruction surrounding that practice.**

Fluency and Flexibility

Fluency is more than speed. A fluent student can recall a fact or derive it efficiently from a known relationship. With continued practice, useful relationships become increasingly efficient, and many facts become automatic.

> **Key Idea • Flexibility gives students something to reason from when recall is not immediate. Automaticity reduces the attention routine calculations require. Students need both.**

Making the Relationship Visible

The intervention used physical, visual, and symbolic representations to make multiplication relationships visible. The goal was not to move students through a fixed sequence of representations. It was to help students connect the same mathematical relationship across models and notation.

> **Key Idea • A model earns its place when it makes a relationship students can reason about visible.**

Building 7 × 8 From Known Relationships

Suppose a student does not immediately recall 7 × 8 but knows 5 × 8 and 2 × 8.

$$7 \times 8 = (5 \times 8) + (2 \times 8) = 40 + 16 = 56$$

The unit is 8. Seven tells how many times that unit is iterated. The seven iterations can be decomposed into five iterations and two iterations. With repeated use, that reasoning can become increasingly efficient until 7 × 8 is recalled automatically.

> **Key Idea • The student is not avoiding the fact. The student is building it from known relationships.**

What We Did

Third-, fourth-, and fifth-grade students from Title I schools with below-average performance on the state achievement test participated, 282 students in all. Schools were randomly selected for one condition or the other, and whole classes took part, so the design was quasi-experimental. In Grades 3 and 5, the strategy-based group was a single class. For five weeks, each class spent 10 to 15 minutes a day on multiplication facts.

The drill-based classes took a timed fact test each day, followed by flashcard practice, songs, and mnemonic exercises. The strategy-based classes built arrays with physical models such as tiles, used a blank 12-by-12 grid as a multiplication table to record derived-fact strategies, discussed how related facts could be used, and made strategy cards: flash cards with a preferred derived-fact strategy on the back.

Students completed a one-minute test of 30 multiplication facts before and after the five weeks. The measure was the number of correct facts in one minute.

> **Key Idea • Both groups spent five weeks practicing multiplication facts. The instruction around the practice differed.**

What Happened

Averaged across the three grades, the strategy-based group gained 6.08 correct facts per minute and the drill-based group gained 0.79 (Brendefur et al., 2015). Figures 1 to 3 show the pretest and posttest results for each grade.

In Grade 3, the strategy-based group gained 6.52 correct facts per minute, and the drill-based group declined by 2.00. In Grade 4, the gains were 6.65 and 2.00. In Grade 5, they were 5.08 and 2.36. The difference between the groups was statistically significant in every grade.

The drill-based group improved in Grades 4 and 5 and declined in Grade 3. Importantly, students did not have to choose between reasoning and fluency. The instruction used mathematical relationships to develop fluency.

Figure 1. Grade 3 performance on a multiplication fluency pretest and posttest by group. Error bars represent the standard error of the mean.

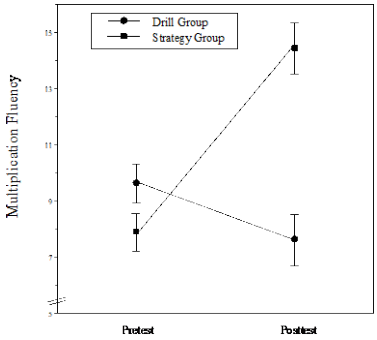


Figure 2. Grade 4 performance on a multiplication fluency pretest and posttest by group. Error bars represent the standard error of the mean.

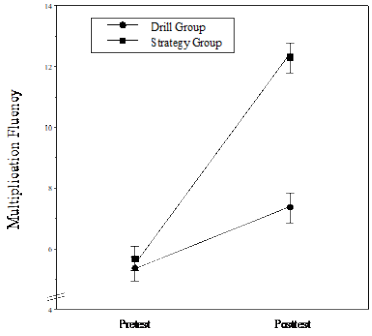
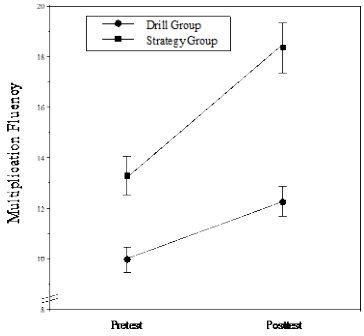


Figure 3. Grade 5 performance on a multiplication fluency pretest and posttest by group. Error bars represent the standard error of the mean.



> **Key Idea • Students did not have to choose between reasoning and fluency. The instruction used mathematical relationships to develop fluency.**

What the Results Suggest

The results do not suggest that practice is unimportant. Both groups practiced, and the drill-based group also improved in two of the three grades.

The difference suggests that practice can be more productive when students have mathematical relationships to reason from. Known facts, models, and derived strategies give students ways to reconstruct an unknown fact. Repeated use can then make those relationships increasingly efficient.

The study has limits. Classes, not individual students, were assigned to the two conditions; the instruction lasted five weeks, and the sample was too small to examine results for students in special populations (Brendefur et al., 2015).

> **Key Idea • Practice can be more productive when students have mathematical relationships to reason from.**

Implications

The results point to three implications for fact instruction.

1. **Build unknown facts from known relationships.** Ask: What fact do you already know that could help?
2. **Use a model when it makes the relationship visible.** Arrays, area models, ten-frames, and number lines should help students see the relationship they are using, not become additional procedures to memorize.
3. **Practice for efficiency.** Once students have a relationship to reason from, repeated practice should reduce steps and help more facts become automatic.

> **Key Idea • Known relationship, derived fact, repeated use, increased efficiency, automaticity.**

Conclusion

Students need multiplication facts they can access efficiently. This study suggests that repeated practice is not the only part of developing that fluency. Students also benefit from mathematical relationships they can reason from when recall is not immediate.

Students in the strategy-based condition practiced facts while reasoning from known relationships and representations. They became more fluent, not less.

> **Key Idea • Understanding and automaticity do not have to compete. Build the relationship. Practice it. Make it increasingly efficient.**

References

Brendefur, J. L., Strother, S., Thiede, K., & Appleton, S. (2015). Developing multiplication fact fluency. *Advances in Social Sciences Research Journal, 2*(8), 142–154. https://doi.org/10.14738/assrj.28.1396

Social Media

Is repeated drill enough to build multiplication fact fluency?

For five weeks, third- through fifth-grade classes practiced multiplication facts for 10 to 15 minutes a day. Some classes used timed tests and flash cards. Others learned to build unknown facts from known facts with arrays, a blank multiplication grid, and strategy cards. Averaged across the three grades, the strategy-based group gained about six correct facts per minute and the drill-based group gained fewer than one. Inside this DMT Insight, we look at:

- What the two groups did during the five weeks
- What happened at each grade
- How 7 × 8 can be built from 5 × 8 and 2 × 8
- Three implications for fact practice

Read the full Insight at mathsuccess.io/dmtinsights.

What do your students have available to reason from while they practice?

