An Exploration of Fact Fluency in 150,000 Elementary Students

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Agenda

- Background on fact fluency
- Design of current study
- Results
- Discussion

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Definitions

- Basic facts: Single-digit addition and subtraction problems

- *Fluency*: **accuracy** with **speed**
  (Van der Ven, Segers, Takashima, & Verhoeven, 2017)

- Benefits:
  - Frees working memory
  - Predicts later achievement in mathematics

(Baroody, Eiland, Purpura, & Reid, 2013; Codding & Martin, 2016; Geary, 2010; Geary et al., 2009; Gersten et al., 2009)

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Developing Fluency

Accuracy & Speed

Counting

Other meaningful strategy use

Recall

(Baroody, Bajwa, & Eiland, 2009; Gersten et al., 2009; National Research Council, 2001)

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Meaningful strategies

- Deriving unknown facts from known "helper" facts

6 + 6 = 12 → **6 + 7 = (6 + 6) + 1**
= 12 + 1 = 13

- Using properties

4 + 3 = 7 → **3 + 4 = 7**

7 + 8 = 15 → **15 - 8 = 7**

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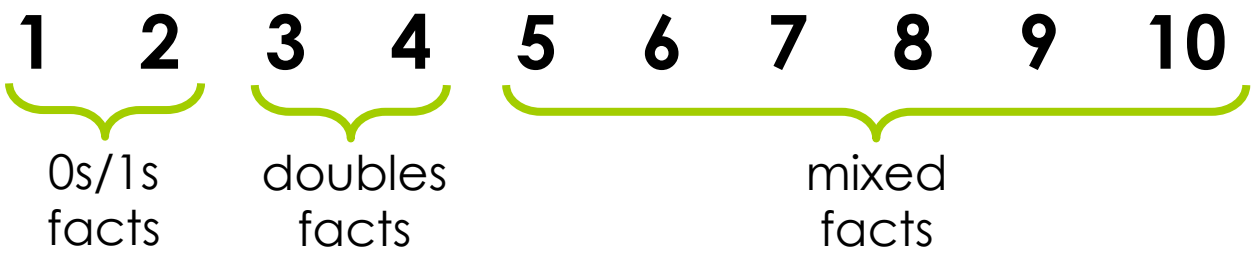
Current study: The *Facts Workshop Game*

- Played by thousands of students
- Performance on doubles and 0s/1s tracked separately
- 10-question rounds of play:



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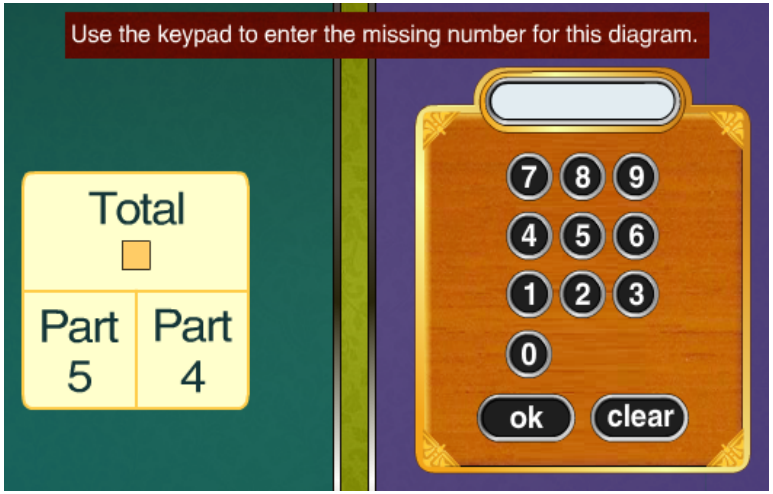
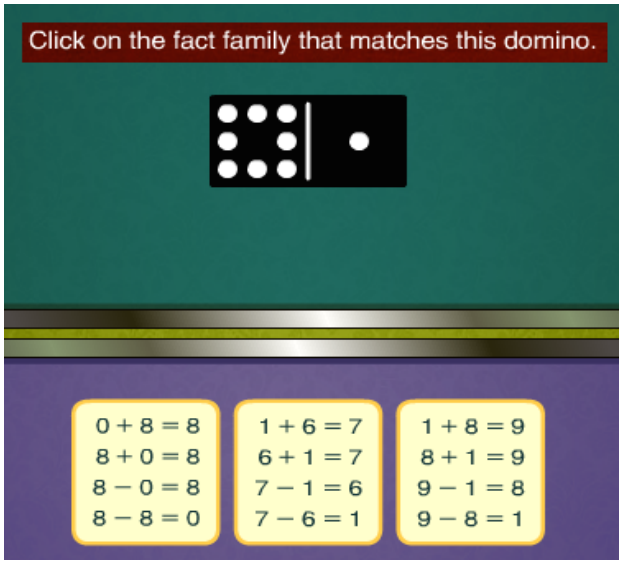
Facts Workshop Game

- Fact-family approach





- For this study, we looked only at basic facts in untimed mode.

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Research Questions

1. What are students' fluency levels with different groups of basic addition and subtraction facts?

2. In what order and combinations do students appear to become fluent with different fact groups?

3. Which fact groups, once mastered, appear to support fluency with other fact groups?

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Sample

- All students who completed at least one complete round of 10 questions
  - N = 155,628
- Most completed very few rounds
- Students were in G2, G3, G4

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Measure

- For each question, game records:
  - Correct or incorrect (accuracy)
  - Milliseconds to respond (speed)
- Our measure of fluency (accuracy + speed):
  - Average time to respond *correctly*
- Aggregated by student and by fact group
- Discarded data from first question in round

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Analysis Plan

- Fluency codes:

Fluent	Medium	Slow
6 sec or less	6+ to 15 sec	15+ sec

(Purpura, Baroody, Eiland, & Reid, 2016)

- **RQ1:** No. of students Fluent on each fact group.
- **RQ2:** No. of students with each combination of Fluent fact groups.
- **RQ3:** Relationships between Fluency on 0s/1s and doubles and Fluency on mixed facts

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Results: Question 1

Percent of students with each fluency code

Fluency Code	0s/1s	Doubles	Mixed
Fluent	25.12	32.05	12.13
Medium	56.87	54.97	69.09
Slow	18.02	12.99	18.79

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Results: Question 2

Students Fluent on each combination of fact groups

Fluent Fact Groups	% Students
None	55.41
Doubles	14.10
0s/1s	9.44
0s/1s, Doubles	8.92

32%

Fluent Fact Groups	% Students
All	5.45
Doubles, Mixed	3.57
Mixed	1.80
0s/1s, Mixed	1.31

7%

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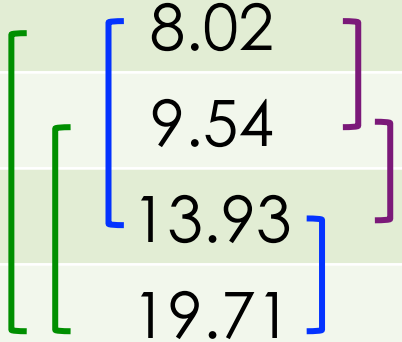
Results: Question 3

Fluent Helper Fact Groups	Mean Speed on Mixed Facts (s)
Both	8.02
Doubles	9.54
0s/1s	13.93
Neither	19.71



$p < 0.001$ in all comparisons

Large effects

Medium effects

Small effects

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Discussion

- General support for theory of "helper facts":
  - 0s/1s and doubles seem to be acquired first and more easily.
  - Fluency on each helper fact group is associated with faster speed on mixed facts.

Future Directions

- Exploring the role of other variables in the game (style of question presentation, time limits).
- Other studies of other helper-fact groups. In particular, combinations of 10.

Thank you! Questions?

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