Exploring How Time Tracking Affects Student Fact Performance

Kathryn Rich & Meg Bates

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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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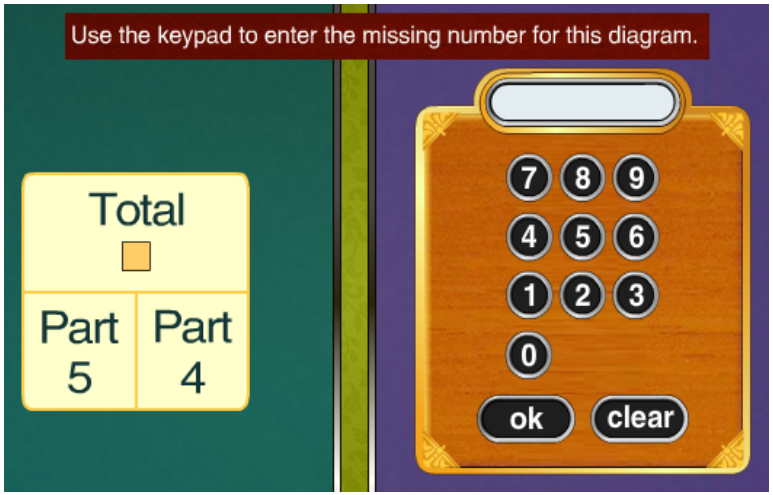
Role of Speed

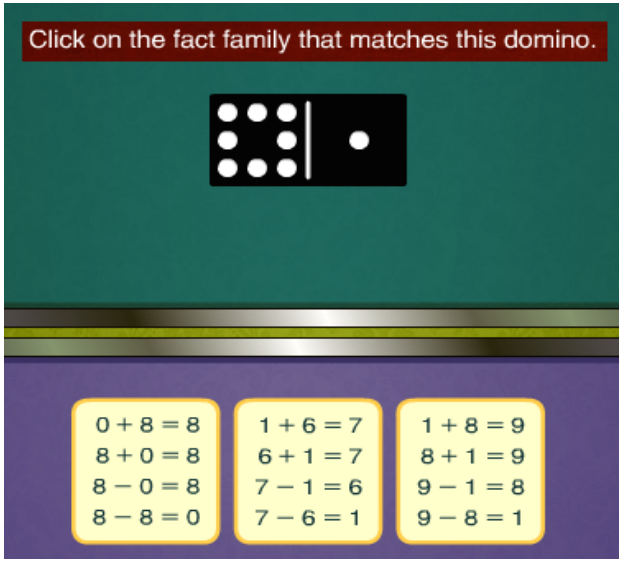
- How do we support the development of fluency – particularly speed?
- Timed tests….

- What is it about timed tests – or their implementation – that is problematic?

Current study: The *Facts Workshop Game*

- Fact-family approach





- Students attempt questions until they answer 10 questions correctly.

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Facts Workshop Game

- Students choose a timing mode.

No Time	**Beat Your Time**	**Time Limit**
No time limit.	No time limit.	6 sec time limit.
Time does not factor into score.	Total time is tracked and compared to previous games.	If students do not respond in 6 sec, incorrect response is recorded.

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Research Question

How does students' chosen timing mode relate to their overall rates of accuracy and speed when playing the *Facts Workshop Game?*

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Sample

- All students who completed at least one complete round of 10 questions in each timing mode.
  - N = 886
- Students were in G2, G3, G4

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Measures

- For each question, game records:
  - Correct or incorrect
  - Milliseconds to respond
- Our measure of **Accuracy:**
  - Questions *attempted* / Questions correct
  - Accuracy ratio of 1 is perfect
  - Higher ratio means less accuracy
- Our measure of **Speed:**
  - Average time in seconds to answer *correctly*.
  - Incorrect attempts were discarded from speed calculation.

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Analysis Plan

Data was skewed and overdispersed, so we used non-parametric methods.

Overall test of significant effect of timing mode:

Friedman Rank-Sum test

Post-hoc pairwise comparisons:

Wilcoxon Signed Rank tests (Bonferroni adjustment)

Effect size: **Cliff's Delta**

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Results: Accuracy

Mean and median accuracy by timing mode

Timing Mode	Mean Accuracy	Median Accuracy
No Time	1.23	1.11
Beat Your Time	1.25	1.13
Time Limit	1.48	1.33

Medium effects
Δ = 0.42, 0.47

No practical difference b/t No Time and Beat Your Time

$p < 0.001$ for all comparisons except
No Time vs Beat Your Time ($p = 0.002$)

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Results: Speed

Mean and median speed (s) by timing mode

Timing Mode	Mean Speed	Median Speed
Time Limit	3.68	3.49
Beat Your Time	6.42	5.21
No Time	9.02	7.32

$p < 0.001$ for all comparisons

Large effects
$\Delta = 0.59, 0.82$

Medium effect
$\Delta = 0.35$

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Discussion

- Time Limit mode was associated fastest speed but lowest accuracy.
  - Consistent with theories that time limits are detrimental to fact learning.
  - **HOWEVER:** We interpret this with caution, as running out of time is treated as an incorrect answer in the data.
  - Unreported post-hoc analysis: Pattern holds when looking only at facts answered within 6 s.

Discussion

- Even discarding the Time Limit mode, we have a compelling result:

Beat Your Time mode was associated with faster speeds than No Time mode, with no detriment to accuracy.

- One explanation: Any negative effects of time on accuracy may be associated with time *limits* but not time *tracking,* and that time *tracking* can support the development of speed.

- Are there connections to metacognition?

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Thank you! Questions?

- Katie Rich
  @KatietheCurious
  richkat3@msu.edu

- Meg Bates
  @megbates_stemed
  megbates@uchicago.edu

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