Developing and Assessing Addition Fact *Fluency* in Meaningful Ways

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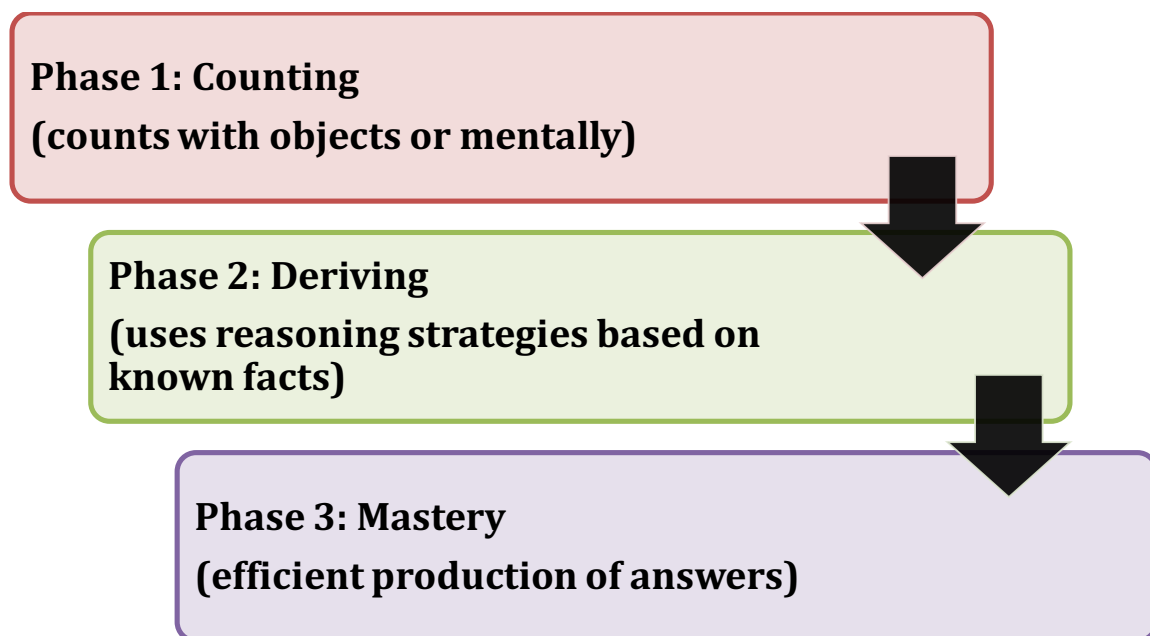j.baywilliams@louisville.edu

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Procedural Fluency is skill in carrying out procedures flexibly, accurately, efficiently and appropriately.

(NCTM, 2014; CCSSO, 2010; NRC, 2001)

Phases of Basic Fact Mastery (Baroody, 2006)

Phase 1: Counting
(counts with objects or mentally)

Phase 2: Deriving
(uses reasoning strategies based on known facts)

Phase 3: Mastery
(efficient production of answers)

Indicators for each phase for the example 5 + 7 = ?

Phase 1: The child uses fingers to help keep track of his counts as he either counts all or counts on to find the sum.
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Phase 2: The child uses a known fact such as 5 + 5 and thinks "5 + 5 = 10 and 2 more will make 12. So 5 + 7 = 12."

Phase 3: The child answers "12" with little/no hesitation.

Key Games for Developing Fact Fluency

Go Fish for 10s

This 2–4 player game is played like the card game "Go Fish," only instead of looking for matching cards, children look for combinations of ten. For example, if a child has a 4 in his hand, he would ask another player "Do you have a 6?" Use numeral cards or playing cards with numbers 0–10 (Ace = 1, Queen = 0). Children can continue to draw extra cards as needed, and play continues until all cards are used. Children can then be encouraged to share or record the number sentences for some of the pairs that they found to reinforce the combinations of ten.

Erase

This 2–4 player game is inspired by the classic game "Sevens." Using a deck of cards with numbers 0–10 (Ace = 1, Queen = 0), calculators (optional), players take turns turning over 7 cards and look for cards that can form a combination of 10 to remove, or "erase" from their hand. The remaining cards are summed to produce the player's score for that round. The player with the lowest score wins.

Lucky 13

Form a group of 2–4 and use one deck of cards (omitting face cards and using aces as ones, jacks as zeros). Each player turns over 5 cards. At the same time, each player selects 2 cards which, when added together, result in a sum as close to Lucky 13 as possible. Players find how far their sum is from Lucky 13 and record that difference as their score (e.g., if the two cards add to 11, the score is 2 because 11 is 2 away from 13). Players discard the two cards that were used and draw two new cards. Repeat for 5 rounds. The lowest total score wins!

Salute!

Played in a group of three with a deck of cards (omitting face cards and using aces as ones, queens as zeros). Two players draw a card without looking at it and place it on their foreheads facing outward (so the others can see it). The player with no card tells the sum. The other two players determine the value of their cards. Once both players have done so, they look at their cards and then players rotate roles before starting the next hand. Adaptations include restricting cards used (e.g., addition facts using only the numbers 1 through 5) or focusing on multiplication/division.

Developmental Sequence for Addition Fact Strategies

Foundational Facts	
Sums within 5 (1 + 4, 2 + 2, etc.)	Work with Foundational Facts begins in Kindergarten, with a focus on mastery in First Grade. Derived Fact Strategies (see below) are a focus of First and Second Grades.
+ 1 or 2	
Doubles (2 + 2, 6 + 6, etc.)	
Combinations of 10 (3 + 7, 8 + 2, etc.)	
10 + facts (10 + 3 = 13, etc.)	
Derived Fact Strategies	
Near Doubles (6 + 7, 8 + 7, etc.)	Start with a nearby known double and add or subtract 1 or 2 from it to derive the unknown fact. *Ex: I don't know 6 + 7, so I think **6 + 6 = 12** and add 1 more to get 13.*
Making Ten (8 + 3, 9 + 5, etc.)	Decompose one addend in order to form a combination of 10 with the other addend and then add the remaining number. *Ex: I don't know 9 + 5, so I think 9 + 1 = 10 and 4 more is 14.*
Pretend-a-10 (8 + 7, 9 + 6)	"Pretend" the number closest to 10 is a 10, add the 10 and the other addend, then subtract 1or 2 from the sum. *Ex: I don't know 8 + 7, so I pretend the 8 is a 10. 10 + 7 = 17, and 17 – 2 = 15, so 8 + 7 = 15.*

Questions to Ask While Playing Facts Games

Questing is important to encourage good mathematical thinking during game play:

- *How did you figure it out?*
- *Can you say out loud how you thought about it in your head?*
- *Is there another way you could figure it out?*
- *Can you think of another fact that strategy would work well for?*
- *If someone didn't know the answer to _____, how would you tell them to figure it out?*

Facts Assessment: 1st Grade Journal Responses to
If your friend didn't know the answer to 4 + 5, how could he figure it out?

I would tell my friend to yoos a double plus 1. 4+4=8 so count 1 up. now you get your ancer

I would tell my friend to tak away one number from ten. And that is nine. I know that five plus five equals ten.

MAY 10, 2012
I would tell my friend to take 5 and count 4 in your hand

I would tell my friend to start with 5 then add 2 then one more 2 and then You have 9.

Kling, G. & Bay-Williams, J. (April 2014). Assessing Basic Fact *Fluency*. *Teaching Children Mathematics, 20(8)*, 488-497.

Additional Resources for Developing and Assessing Basic Fact Fluency

Jennifer Bay-Williams & Gina Kling (2019). Math Fact Fluency: 60+ Games and Assessment Tools to Support Learning and Retention. Association for Supervision and Curriculum Development (ASCD) and National Council of Teachers of Mathematics (NCTM), Alexandria, VA.
> *A book completely devoted to developing and assessing addition, subtraction, multiplication, and division facts in meaningful, effective ways! Provides detailed descriptions of each basic fact strategy, many games for each phase of basic facts learning, and a variety of fluency-focused assessment tools.*

Gina Kling & Jennifer Bay-Williams (2018). Games and Tools for Teaching Multiplication Facts. Quick Reference Guide. Association for Supervision and Curriculum Development (ASCD), Alexandria, VA.
> *A multi-panel glossy guide with suggestions for activities, games, and assessment techniques designed to encourage multiplication and division fact fluency.*

Jennifer Bay-Williams & Gina Kling (2017). Games and Tools for Teaching Addition Facts. Quick Reference Guide. Association for Supervision and Curriculum Development (ASCD), Alexandria, VA.
> *A multi-panel glossy guide with suggestions for activities, games, and assessment techniques designed to encourage addition fact fluency.*

Gina Kling & Jennifer M. Bay-Williams (2015). Three Steps to Mastering Multiplication Facts. *Teaching Children Mathematics*, *21*, 548-559.
> *Contains a summary of multiplication fact strategies as well as directions for a variety of multiplication facts games.*

Jennifer M. Bay-Williams & Gina Kling (2015). Developing Fact Fluency. Turn Off Timers, Turn Up Formative Assessment. In NCTM *Annual Perspectives in Mathematics Education (APME) 2015: Assessment to enhance learning and teaching.* Chris Suurtamm, (Ed.) National Council of Teachers of Mathematics, Reston, VA.
> *Contains examples of different types of fact assessments that can be used across the three phases of fact mastery.*

Jennifer M. Bay-Williams & Gina Kling (2014). Enriching Addition and Subtraction Fact Mastery through Games. *Teaching Children Mathematics, 21*: 238-247.
> *Contains game directions in the main article as well as detail on how to use the games to help children progress through the three phases of fact mastery.*

Gina Kling & Jennifer M. Bay-Williams (2014). Assessing Basic Fact *Fluency*. *Teaching Children Mathematics, 2:* 488-497.
> *Contains examples of different types of fact assessments that can be used to more accurately capture the four components of fluency.*

Gina Kling (2011). Fluency with Basic Addition. *Teaching Children Mathematics, 18:* 80-88.
> *Contains a summary of basic addition strategies as well as game directions, including games focused on developing foundational fact fluency.*

You are welcome to contact me with any questions or ideas you have to share about basic fact fluency. Thank you for participating in this session! ☺