Rationale and Background for Fact Fluency

Definition and phases:

Fluency is "the efficient, appropriate, and flexible application of single-digit calculation skills and is an essential aspect of mathematical proficiency" (Baroody 2006, p.22). Students proceed through three phases as they develop mastery with any particular set of facts.

1. Modeling Phase: Modeling and/or counting all or counting on to find the answer: For example, using fingers to help keep track of their counts to solve 5+7=?
2. Reasoning Phase: Deriving answers using reasoning strategies based on known facts, such a solving 5+7 by thinking, "Five plus five equals ten, and two more will make twelve."
3. Efficient Phase: Mastery or efficient production of answers. For example, when asked, "What is 5 + 7?" a child might call out, "Twelve," and explain, "I just knew it."

Instruction and practice:

From experience we realize that solely teaching a strategy and then asking students to use it does not mean it will be internalized and applied. This approach removes the student's ability to reason and requires more memorization and therefore lowers number sense. Our goal has shifted from memorizing facts and procedures to increased understanding of the math strategies. We will support student thinking by helping them see when certain strategies are applicable. We begin with building the understanding of each strategy and then move to targeted practice while monitoring progress. The key is to help students see the possibilities and then help them chose the strategy that helps them get to the without counting. Meaningful practice of strategies is a key part of developing fact fluency. Ideas for meaningful instruction and practice activities are provided in this document.

Most of the basic facts are connected to a specific strategy and while several facts fit within multiple strategies, there are a two facts (5+3 and 6+3) that are not specifically addressed. It is important for students to understand that they can use known facts to determine these sums. For example, to find the sum for 5+3, students could use 5+2 and add one more, use the 3+3 doubles fact and add 2 more, or use the make ten fact 7+3 and subtract 2. If students are truly internalizing the fact strategies and using them to think flexibly about numbers, they will easily be able to use a known fact to determine an unknown fact. "Discussions that show flexibility are critical to expanding students' thinking about numbers and the many ways they can be joined or separated" (O'Connell and SanGiovanni 2011, pg 11).

Assessment ideas:

We encourage students to synthesize information to help build understanding. Let us apply this philosophy to fluency. When we think about reading fluency, we imagine listening and observing students as they read and then questioning them to assess reading comprehension. Beyond observation, we also use interviews, performance tasks, and journaling to develop a comprehensive understanding of what a child knows and any misconceptions they may have. These formative assessment ideas can also be applied to fact fluency.

1. Interviews can be used to assess all aspects of fluency. Accuracy would be determined as soon as the student gives an answer, efficiency if based on how long it takes to answer, flexibility and appropriate strategy can be addressed by asking "How did you figure that out?" or "How could you use _____ (strategy) to solve this fact?". Interviews do not need to be a formal sit down event but could be a quick exchange during every day routines or math activities.

2. Observations occur throughout the day and can supply insight to help students learn new strategies and understand new unknown facts. A list of students and strategies and/or phases can be attached to a clipboard for ease of recording observations throughout the math block (warm-ups, number talks, partner work, independent practice, games, etc.) See included example below.
3. Journaling provides an opportunity to assess student's flexibility and application of strategies. Writing prompts such as "Explain how to use the "count on" strategy to solve 2 + 9.", "How can you use 7 x 10 to find the answer to 7 x 9", and "Susie explains that 6 + 7 = 12. Is she correct? Explain how you know." can help teachers see if appropriate strategies, flexibility, and accuracy are occurring. For more ideas for journaling see April 2014 TCM journal article titled "Assessing Basic Fact Fluency".
4. Short **untimed** quizzes that focus on strategies can also be helpful to determine which facts students "just know" and which facts need more practice.

Timed tests:

Timed tests as well as time focused drills and activities (around the world, flash card drills, etc.) offer little insight into a student's ability to be flexible with strategies or in which strategies a student is using. Research suggests that efficiency and accuracy are negatively influenced by timed testing. "Children who were frequently exposed to timed testing demonstrated lower progress toward knowing facts from memory than their counterparts who had not experiences as many timed tests. In fact, growing evidence suggests that timed testing has a negative impact on students." (TCM, April 2014, "Assessing Basic Fact Fluency"). Researchers have found that students experience stress on timed tests that they do not experience even when working on the same problems in an untimed situation. Timed tests may cause even strong mathematical thinkers to become discouraged and develop math anxiety. We, therefore, recommend limited exposure to timed tests. Fortunately, children can learn facts effectively without the use of timed testing using the ideas mentioned above.

Data Collection Tools:

The following pages are a variety of recording sheets to be used for data collection. Data collected about progress through the phases of fluency should drive your instruction with the fact strategies. The chart below shows the phases and coding for data collection.

Coding	Phases of Fluency Development
E	**Efficient Phase:** Mastery or efficient production of answers. For example, when asked, "What is 5 + 7?" a child might call out, "Twelve," and explain, "I just knew it."
R	**Reasoning Phase:** Deriving answers using reasoning strategies based on known facts, such a solving 5+7 by thinking, "Five plus five equals ten, and two more will make twelve."
M	**Modeling Phase:** Modeling and/or counting all or counting on to find the answer: For example, using fingers to help keep track of their counts to solve 5+7=?

Kindergarten

Add/Subtract 1

Add 1: When 1 is added to a quantity, the sum is the next counting number
Subtract 1: When 1 is subtracted from a quantity, the difference is the previous counting number
Examples:

5 + 1 16 + 1
4 – 1 18 - 1

Add/Subtract 0/Differences of 0

Add zero: When 0 is added to a quantity, the sum is the same amount
Subtract zero: When 0 is subtracted from a quantity, the difference is the same amount
Differences of zero: When the same amount is subtracted resulting in a difference of 0.
Examples:

7 + 0 13 + 0 6 – 6
2 – 0 15 – 0 14 – 14

1st Grade

Add*/Subtract 2*

Add 2: When 2 is added to a quantity, the sum is two counting numbers past the quantity
Subtract 2: When 2 is subtracted from a quantity, the difference is the number that is two before the quantity
Examples:

6 + 2 9 – 2

Doubles*/Halves*

Doubling: The sum of joining two equal groups
Halving: Separating a quantity into two equal groups
Examples:

4 + 4 10 + 10
12 – 6 16 - 8

Make 10*/Subtract from 10

Make 10: Two numbers are combined to equal 10
Subtract from 10: a number is subtracted from 10
Examples:

2 + 8 6 + 4
10 – 3 10 - 5

Differences of 1*

When 2 numbers are subtracted the difference is 1
Examples:

7 – 6 9 – 8

Differences of 2*

When 2 numbers are subtracted the difference is 2
Examples:

9 – 7 6 – 4

2nd Grade

Using Doubles*/Using Halves*

Using Doubles: The sum of joining two equal groups plus an additional one more
Using Halves: Separating a quantity into two equal groups and an additional one
Examples:

5 + 6 9 + 8

11 – 5 17 – 8

Adding 10*/Subtracting 10* and Making Differences of 10*

Adding 10: Adding 10 to any single-digit number will result in a teen number.
Subtracting 10: Subtracting 10 from a teen number will result in the number of ones in the ones place.
Making Differences of 10: Subtracting the amount of ones in the ones place of a teen number will result in a difference of 10.

10 + 4 10 + 9
13 – 10 18 – 10
15 – 5 19 – 9

Using 10 to add*/Using 10 to Subtract*

Using 10 addition: Break apart one addend and add a part to the other addend to make ten
Using 10 subtraction: Subtract ten and then add a part back in according to the problem
Examples:

8 + 5 9 + 6

13 – 9 15 – 8

Classroom Observation/Interview Adding/Subtraction One

Student	Date	Add 1	Notes	Date	Subtract 1	Notes
Example: Areal Yardley	9/12	M	9+1 started at 1 and counted all	10/5	M	8-1 Showed 8 fingers, put one down, said 7
	10/1	M	8+1 started at 8 and counted all	11/3	R	6-1 Said 5+1= 6 so one less than 6 is 5.
	10/21	E	7+1 said 8	12/3	E	9-1=8

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Fact Progress Student_____

Modeling			Reasoning			Efficient		
Modeling and/or counting all or counting on to find the answer: For example, using fingers to help keep track of their counts to solve 5+7=?			Deriving answers using reasoning strategies based on known facts, such a solving 5+7 by thinking, "Five plus five equals ten, and two more will make twelve."			Mastery or efficient production of answers. For example, when asked, "What is 5 + 7?" a child might call out, "Twelve," and explain, "I just knew it."		
Kindergarten	First Grade	Second Grade	Kindergarten	First Grade	Second Grade	Kindergarten	First Grade	Second Grade
Add 1 Subtract 1 Add Zero Subtract Zero	Doubles Halves Make Ten Subtract from Ten Add 2 Subtract 2 Differences of 1 Differences of 2	Using Doubles Using Halves Adding Ten Subtracting Ten Making Differences of Ten Using Ten + Using Ten -	Add 1 Subtract 1 Add Zero Subtract Zero	Doubles Halves Make Ten Subtract from Ten Add 2 Subtract 2 Differences of 1 Differences of 2	Using Doubles Using Halves Adding Ten Subtracting Ten Making Differences of Ten Using Ten + Using Ten -	Add 1 Subtract 1 Add Zero Subtract Zero	Doubles Halves Make Ten Subtract from Ten Add 2 Subtract 2 Differences of 1 Differences of 2	Using Doubles Using Halves Adding Ten Subtracting Ten Making Differences of Ten Using Ten + Using Ten -
Date/Notes:			Date/Notes:			Date/Notes:		