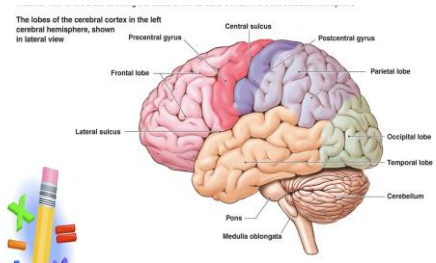
The Neuropsychology of Mathematics:
Developing Evidenced Based Math Interventions



Steven G. Feifer, D.Ed., ABSNP
feifer@comcast.net

1

Course Outline

- Six part webinar series on reading, writing, & math disabilities sponsored by Jack Hirose & Associates.
- Introduce a brain-based educational model of dyslexia, dysgraphia, and dyscalculia and classify each disability into distinct subtypes.
- Discuss targeted interventions for all students with academic learning issues.
- Introduce the concept of diagnostic achievement tests versus traditional achievement tests.
- Questions and Comments: **feifer@comcast.net**

2

2

Presentation Goals

1) Discuss the international trends in math, and reasons why the United States and Canada lags behind other industrialized nations in mathematics.
(2) Explore the role of various cognitive constructs including working memory, visual-spatial functioning, language, and executive functioning, with respect to math problem solving ability.
(3) Discuss <u>three</u> subtypes of math disabilities, and specific remediation strategies for each type.
(4) Discuss the main neural pathways that contribute to the development of number sense and quantitative reasoning.
(5) Introduce the <u>FAM</u>, a diagnostic test of mathematics designed to examine the underlying cognitive processes that support the acquisition of proficient math skills.

3

3

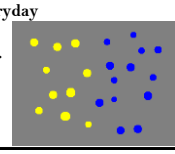
Building a Math Brain: 4 Neurocognitive Factors

1. Approximate Number System - non-symbolic representation of math represented by space and time.
2. Connectivity - linking non-symbolic representations with symbolic representations (numerals) to form our own internal number line.
3. Automaticity - facts and procedures.
4. Quantitative knowledge - mathematical reasoning emerges from the development of *number-sense* as students learn to apply mathematics to real world problems.

4

1. Approximate Number System
(Mazzocco, Feigenson & Halberda, 2011)

- A mental representational system of visual-spatial approximations that may underscore "number sense".
- Emerges independent of instruction (innate) and in non-humans as well. A preverbal skill.
- Distinguishes math LD from students from typical peers.
- Intuitively judging which line at the grocery store is shortest, or whether there is enough milk left in the carton to make breakfast are everyday examples.
- Activation in inferior parietal sulcus.



5

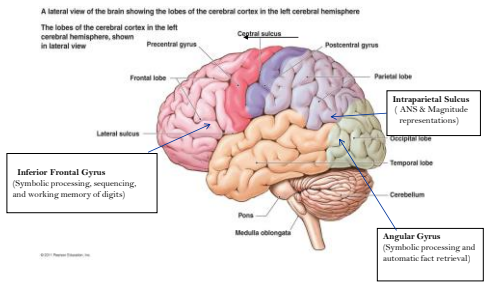
2. Connectivity Hypothesis

Connectivity Hypothesis: Neuroimaging have shown distinct, though overlapping, neural circuits involved with non-symbolic data, and symbolic processing of information (Kucian et al., 2006; Rykhlevskaia et al., 2009; Holloway et al., 2011; Ashkenazi et al., 2014).

- The intraparietal sulcus tends to be involved in the nonsymbolic, or magnitude representation of numbers primarily in the right hemisphere (Rotzer et al., 2008).
- The symbolic processing of digits involves the left angular gyrus and inferior frontal gyrus. (Ansari, 2008; Butterworth & Varma, 2014).

6

Mapping the Math Brain



Symbolic vs. Non-symbolic Brain Regions

7

Measuring Connectivity: The Distance Effect

Distance Effect: when students are presented with two numerals and asked which one is larger, they tend to respond fastest when the numerals are quantitatively far apart, rather than close together (Butterworth & Varma, 2014).

Faster Response	Slower Response
12 94	6 8
3 44	12 11
47 1	31 29
87 15	56 58
17 71	19 17
8 39	81 78

8

Measuring Connectivity: The Distance Effect

Distance Effect: Whenever both numbers are relatively large, response times tend to be slower and less accurate as well (Weber's Law).

- Children with developmental dyscalculia tend to respond more slowly than typical peers when making comparisons between two numbers, even when controlling for IQ and general reading ability (Skagerlund & Traff, 2014).
- A child's reaction time, tends to be an excellent predictor of math fluency and math fact retrieval skills (Holloway & Ansari, 2009).

Faster Response	Slower Response
12 94	1,211 1,221
3 44	38,004 38,409
47 1	987 978
87 15	10,242 10,202
17 71	261,789 261,689
8 39	8,111 8,101

9

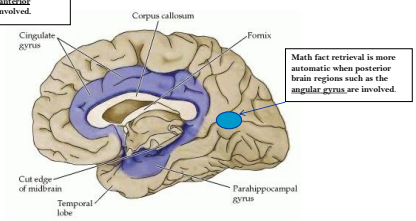
3. Math Facts and Brain Organization

- As number processing becomes more automatic, there is a shift of effortful control toward the back of the brain (Ashkenazi et al., 2014; Cho et al., 2012).
- Children with dyscalculia use more inefficient strategies, especially with subtraction (Rosenberg-Lee et al., 2015).
- Typically developing children often show a rapid shift from using slower, effortful counting strategies toward using more direct forms of automated fact retrieval by 3rd grade (Geary, 2004).

10

Mapping the Math Brain

Math fact retrieval is very effortful, slower, and requires more sustained attention when the anterior cingulate gyrus is involved.



Math fact retrieval and the brain
(Cho et al., 2012)

11

4. Quantitative Knowledge: The Key for Higher Level Math Skills

- The development of quantitative knowledge is critical to comprehend more complex mathematics, as well as to establish cognitive flexibility when problem solving.
- Often dependent upon a variety of neuropsychological constructs including both visual spatial and symbolic reasoning and executive functioning skills.
- For example, the ability to develop a base-10 understanding of numerals and trans-code challenging equations into more palatable forms of operations requires good executive functioning skills. Take the equation 9 X 16 = ____.

12

4. Developing Number Sense & Quantitative Knowledge

- Heidi's Game - Instructional level grades K-2
  - Includes numeral cards and dot cards.
  - Give bonus points for each new rule and write on board.

- Dwain's Game - Instructional level grades 3-5.
  - 3 types of cards…fractions, decimals, and pictures.
  - Cards can use more complex numerals.

- The "24" Game: http://www.4nums.com/

13

Singapore Mathematics

Singapore Math – based upon math philosophy taught in Singapore…gained popularity after TIMSS study.

- Emphasis is on building upon math concepts so re-teaching is not needed, and little time devoted to reviewing previously taught skills before new concept taught.
- Flow of information is from Concrete to Pictorial to Abstract.
- The need for repetitive drill is minimized by logical sequencing of topics.
- The use of Bar-Models, which represent arithmetic quantities by line segments, facilitate understanding eliminate the need of rote memorization of facts.
- Word problems use to build semantic understanding of concepts.

14

Evidenced Based Math Programs

1. *Lindamood Bell "On Cloud Nine"* – helps children visualize number concepts and develop math reasoning skills.
2. *Fraction Face-Off* – a game where students are in teams to earn fraction money by understanding part-whole interpretations.
3. *Number Worlds* – intended for 1st -8th grades to supplement daily math instruction. Students take placement test. Recommended 45-60 min/day.
4. *Dreambox Learning* – grades K-6 online learning program that focuses on numbers, place value, and developing number sense.
5. *EnVision Math* - Alligned with common core for students K-6. Includes daily assessments (Pearson).
6. *I Can Learn Algebra* - designed for more inner city and students in grades 6-12. Computer based and consists of 130 lessons and 45 hours of instructional video.

15

Websites for Math

1. **Math is Fun**
http://www.mathsisfun.com/index.htm

- Math Is Fun is a website that offers some great math resources for k-12 students and teachers. These resources include worksheets, games, exercises, activities, lesson ideas and many more

2. **Illuminations**
http://illuminations.nctm.org/Default.aspx

- Illuminations is a project designed by the National Council of Teachers of Mathematics (NCTM). It provides access to quality standards-based resources for teaching and learning mathematics, including interactive tools for students and instructional support for teachers.

16

Websites for Math

3. **Math Crunch (Yup)**
http://mathcrunch.com/

- Math Crunch is a fast way to get help with math on your phone. Submit a problem, instantly connect with an experienced tutor, reach a solution and most importantly…. learn about math.

4. **Cool Math**
http://www.coolmath.com/

- Offers explanations for algebra and calculus…but coolmath4kids is website for children under 12 with games and activities.

17

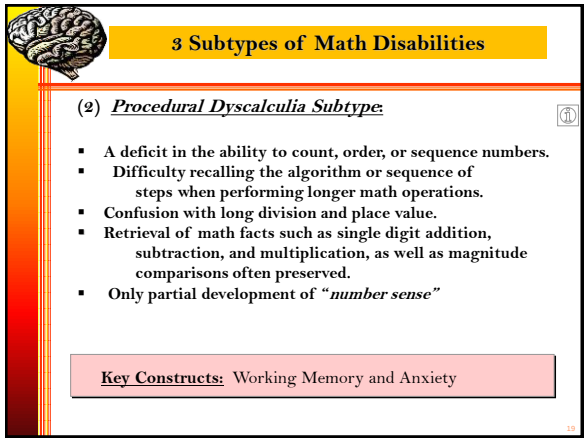
3 Subtypes of Math Disabilities

(1) ***Verbal Dyscalculia Subtype:***
Main deficit is the automatic retrieval of number facts which have been stored in a linguistic code.

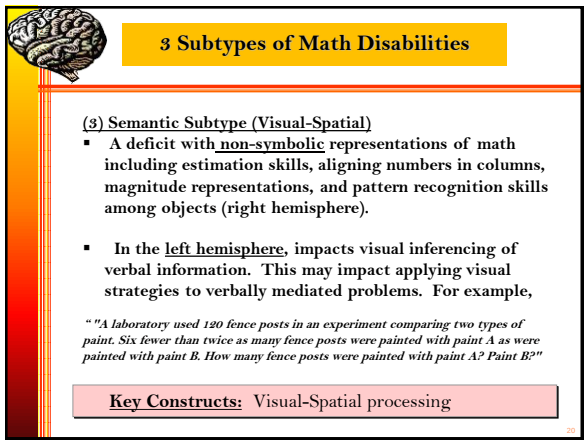
- Over-reliance on manipulatives when problem solving.
- Multiplication and addition often impaired.
- Poor at math fluency tests.
- Math algorithms often preserved.
- Often have learning disabilities in language arts as well.

Key Constructs: Language & Verbal Retrieval Skills

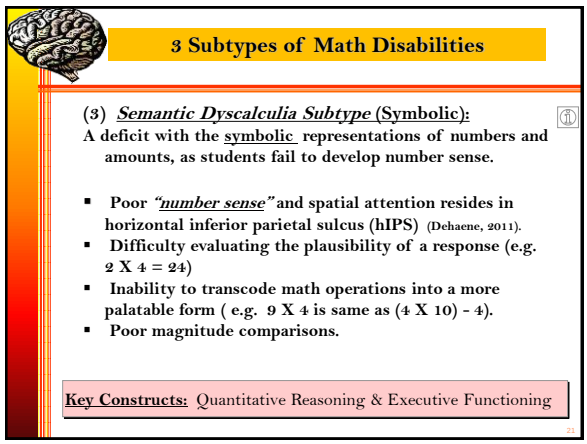
18


3 Subtypes of Math Disabilities
(2) Procedural Dyscalculia Subtype:
A deficit in the ability to count, order, or sequence numbers.
Difficulty recalling the algorithm or sequence of steps when performing longer math operations.
Confusion with long division and place value.
Retrieval of math facts such as single digit addition, subtraction, and multiplication, as well as magnitude comparisons often preserved.
Only partial development of "number sense"
Key Constructs: Working Memory and Anxiety

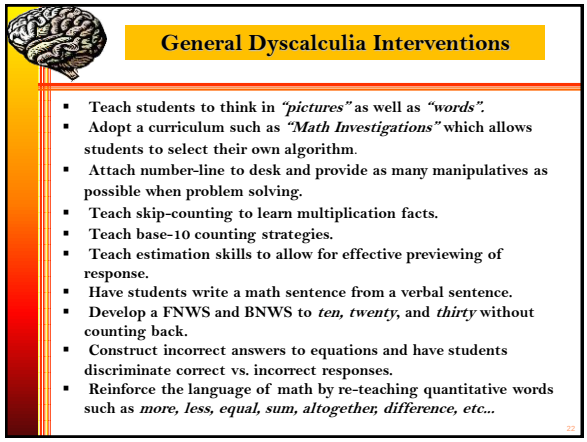
19


3 Subtypes of Math Disabilities
(3) Semantic Subtype (Visual-Spatial)
A deficit with non-symbolic representations of math including estimation skills, aligning numbers in columns, magnitude representations, and pattern recognition skills among objects (right hemisphere).
In the left hemisphere, impacts visual inferencing of verbal information. This may impact applying visual strategies to verbally mediated problems. For example,
" "A laboratory used 120 fence posts in an experiment comparing two types of paint. Six fewer than twice as many fence posts were painted with paint A as were painted with paint B. How many fence posts were painted with paint A? Paint B?"
Key Constructs: Visual-Spatial processing

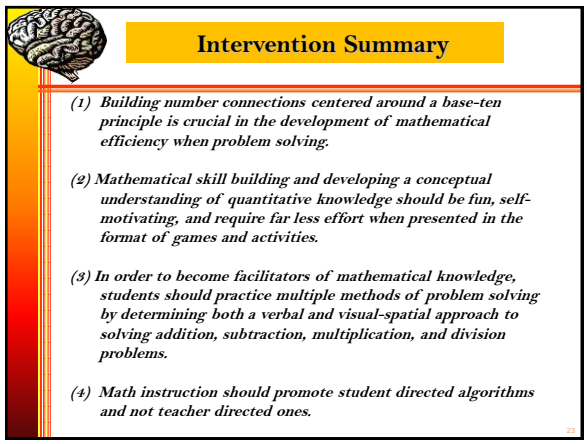
20


3 Subtypes of Math Disabilities
(3) Semantic Dyscalculia Subtype (Symbolic):
A deficit with the symbolic representations of numbers and amounts, as students fail to develop number sense.
Poor "number sense" and spatial attention resides in horizontal inferior parietal sulcus (hIPS) (Dehaene, 2011).
Difficulty evaluating the plausibility of a response (e.g. 2 X 4 = 24)
Inability to transcode math operations into a more palatable form (e.g. 9 X 4 is same as (4 X 10) - 4).
Poor magnitude comparisons.
Key Constructs: Quantitative Reasoning & Executive Functioning

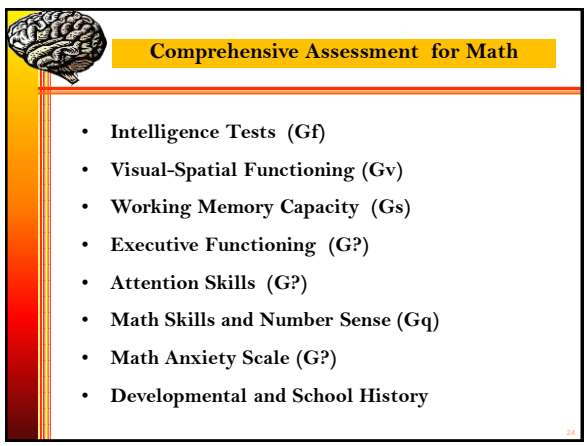
21


General Dyscalculia Interventions
Teach students to think in "pictures" as well as "words".
Adopt a curriculum such as "Math Investigations" which allows students to select their own algorithm.
Attach number-line to desk and provide as many manipulatives as possible when problem solving.
Teach skip-counting to learn multiplication facts.
Teach base-10 counting strategies.
Teach estimation skills to allow for effective previewing of response.
Have students write a math sentence from a verbal sentence.
Develop a FNWS and BNWS to ten, twenty, and thirty without counting back.
Construct incorrect answers to equations and have students discriminate correct vs. incorrect responses.
Reinforce the language of math by re-teaching quantitative words such as more, less, equal, sum, altogether, difference, etc...

22


Intervention Summary
(1) Building number connections centered around a base-ten principle is crucial in the development of mathematical efficiency when problem solving.
(2) Mathematical skill building and developing a conceptual understanding of quantitative knowledge should be fun, self-motivating, and require far less effort when presented in the format of games and activities.
(3) In order to become facilitators of mathematical knowledge, students should practice multiple methods of problem solving by determining both a verbal and visual-spatial approach to solving addition, subtraction, multiplication, and division problems.
(4) Math instruction should promote student directed algorithms and not teacher directed ones.

23


Comprehensive Assessment for Math
Intelligence Tests (Gf)
Visual-Spatial Functioning (Gv)
Working Memory Capacity (Gs)
Executive Functioning (G?)
Attention Skills (G?)
Math Skills and Number Sense (Gq)
Math Anxiety Scale (G?)
Developmental and School History

24

Comprehensive Assessment for Math

MATH:	Wechsler Individual Achievement Test- 3rd Edition
	Woodcock Johnson IV Achievement Test
	Kaufman Test of Educational Achievement (KTEA-III)
	Test of Early Mathematics Ability – 3rd Edition (TEMA-3)
	Comprehensive Mathematical Abilities Test (CMAT)
	Test of Mathematical Abilities -3rd Edition (TOMA-3)
	WRAT-3
	Academic Achievement Battery (AAB)
	KEYMATH-3
	PAL II Mathematics
Executive Functions:	Wisconsin Card Sort Test
	NEPSY II (Animal Sorting, Design Fluency)
	BRIEF II
	CEFI
	Woodcock Johnson IV (Number Series)
	DKEFS (Delis-Kaplan Executive Function Scale)
	D-REF (Delis Rating of Executive Functioning)
	Test of Executive Control
Visual-Spatial:	SB5 (Visual-Spatial Processing, Quantitative Reasoning)
	DAS (Matrices, Recall of Designs, Pattern Construction
	WJIV (Visualization)
	NEPSY II (Arrows, Picture Puzzles, Geom Puzzles)
	Rey-Osterrieth Complex Figure Test
	TONI-3/RIAS (NIX Index)/KABC-II (Gestalt Closure)

25

25

Comprehensive Assessment for Math

Working Memory:	WISC 5 (Picture Span)
	WISC V Integrated
	SB5 (Verbal & Nonverbal Working Memory)
	Test of Memory and Learning (Digits & Letters Backwards)
	DKEFS (Trailmaking Test)
	Cognitive Assessment System -2(Planned Connections)
	Children's Memory Scale (Dot Locations, Sequences)
	Woodcock Johnson IV (Verbal Attention)
	Wechsler Memory Scale (Visual Reproduction & Paired Associate)
	Wide Range Assessment of Memory and Learning -II (Verbal Working Memory & Symbolic Working Memory)
	PAL II: Quantitative and Spatial Working Memory
Attention:	Tea-CH II
	NEPSY II(Auditory Attention and Response Set)
	CAS-2 (Number Detection, Receptive Attention)
	WJIV (Number Pattern Matching)
	KABC II (Number recall)
	Behavior Scales (ACTers, ADDES, Brown, BASC III, Conners'3)

26

26

Assessment Summary for Math

1. Verbal Dyscalculia:
   - Slower fact retrieval skills.
   - Difficulty with word problems.
   - Co-morbid reading/writing difficulties

2. Procedural Dyscalculia:
   - Forget math procedures
   - Better with single-digit facts than longer operations.
   - Working memory limitations

3a. Semantic Dyscalculia: (Visual-Spatial):
   - Difficulty aligning math columns.
   - Poor spatial memory.
   - Poor estimation skills.

3b. Semantic Dyscalculia: (Symbolic)
   - Difficulty transcoding math operations
   - Poor magnitude representations (symbols)
   - Poor conceptual knowledge and quantitative thinking

27

27

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- A neurodevelopmental assessment of mathematics
- Pre-K to College (Ages 4-21)
- Normative sample included 1,061 students
- 19 subtests in complete battery
- Diagnoses **3** subtypes of math disorders
- Includes the FAM-S dyscalculia screening battery
- Total Fam index score and **3** math index scores:
  a) Procedural subtype
  b) Verbal subtype
  c) Semantic subtype
- **Qualification Level:** S or B

28

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Dyscalculia Subtypes

- **Procedural** – a deficit in the ability to count, order, or sequence numbers or mathematical procedures. Often, there are limitations with symbolic working memory and pattern recognition.

- **Verbal** – an inability to use language-based procedures to assist in arithmetic skills. Difficulties with rapid number identification skills, and retrieving stored mathematical facts.

- **Semantic** – a core deficit in both visual-spatial and symbolic components of mathematics . Deficits include poor estimation skills, difficulty aligning numbers in columns, poor magnitude representations, and difficulty selecting a particular mathematical strategy to solve real world problems.

29

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Structure of the FAM

Index	Subtest	Grade range	Approximate administration time
Procedural Index (PI)	Forward Number Count (FNC)	PK to college	5 minutes
	Backward Number Count (BNC)	K to college	5 minutes
	Numeric Capacity (NCA)	PK to college	3 minutes
	Sequences (SEQ)	PK to college	5 minutes
	Object Counting (OC)	PK to Grade 2	5 minutes
Verbal Index (VI)	Rapid Number Naming (RNN)	PK to college	1 minute
	Addition Fluency (AF)	K to college	1 minute
	Subtraction Fluency (SF)	K to college	1 minute
	Multiplication Fluency (MF)	Grade 3 to college	1 minute
	Division Fluency (DF)	Grade 3 to college	1 minute
	Linguistic Math Concepts (LMC)	PK to college	6 minutes
Semantic Index (SI)	Spatial Memory (SM)	PK to college	5 minutes
	Equation Building (EB)	Grade 3 to college	4 to 6 minutes
	Perceptual Estimation (PE)	PK to college	5 minutes
	Number Comparison (NCO)	PK to college	2 minutes
	Addition Knowledge (AK)	K to college	2 minutes
	Subtraction Knowledge (SK)	K to college	2 minutes
	Multiplication Knowledge (MK)	Grade 3 to college	2 minutes
	Division Knowledge (DK)	Grade 3 to college	2 minutes

30

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Procedural Index

1. Forward Number Count - 30 items
2. Backward Number Count - 30 items
3. Numeric Capacity - 16 items
4. Sequences - 39 items
5. Object Counting – 24 items

Basal & Ceiling Rules: 4 correct and 4 incorrect

31

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Forward Number Count (All Grades)

"We are going to do some counting."

Sample Items

"What number comes after 0?"
Correct Answer: 1

"Starting at 4, count forward by fours"
Correct Answer: 4 8 12 16

32

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Backward Number Count (Grades K+)

"Now, we are going to count backward."

Sample Items

"What number comes before 13?"
Correct Answer: 12

"Starting at 50, count backward by fives"
Correct Answer: 50 45 40 35

33

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Numeric Capacity (All Grades)

"I'm going to say some numbers and I want you to repeat them back to me in exactly the same order."

Sample Item

"7 4 3 6 2 9 1"

34

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Sequences (All Grades)

"For these items, I want you to look at the pattern or sequence and tell me what goes in the blank space. You can answer by pointing or telling me."

Sample Item (Prek-2nd)

3rd- 8th grades: 5, 10, 15, _____, 25, 30

35

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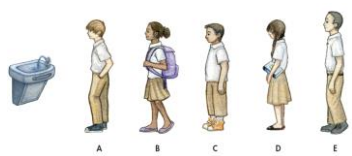
Object Counting (PK through Grade 2)

"I'm going to ask you some counting questions."

Sample Item

"Which child is 3rd in line?"



36

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Verbal Index

1. Rapid Number Naming – Timed subtest: 30 seconds
2. Addition Fluency - Timed subtest: 30 seconds
3. Subtraction Fluency - Timed subtest: 30 seconds
4. Multiplication Fluency - Timed subtest: 30 seconds
5. Division Fluency - Timed subtest: 30 seconds
6. Linguistic Math Concepts – 50 items

Basal & Ceiling Rules: 4 correct and 4 incorrect

37

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Rapid Number Naming (All Grades)

"I want you to name some numbers as quickly as you can."
(30 sec)

1	2	5	3	4	5	2	1	4	3	5	2	1
6	3	9	4	1	8	2	6	5	7	9	4	6
3	7	1	9	2	5	3	8	4	6	1	9	2
1	5	8	3	6	9	7	2	4	8	5	2	1
2	7	6	9	3	5	1	4	8	5	6	7	3
5	4	8	2	7	9	3	1	2	6	4	5	7
9	3	7	4	5	8	6	2	1	7	9	3	8

38

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Addition Fluency (Grades K+)

"I want you to answer some addition problems as quickly as you can without skipping any. You do not need to read the problems aloud, only say your answers."

2 + 1	2 + 2	3 + 2	3 + 1	1 + 1	1 + 3
1 + 4	2 + 8	4 + 2	2 + 7	6 + 4	2 + 0
3 + 4	9 + 1	6 + 1	3 + 3	1 + 8	4 + 1
3 + 0	2 + 4	5 + 2	9 + 0	8 + 2	7 + 4
5 + 6	6 + 6	5 + 4	0 + 7	7 + 5	7 + 8
9 + 7	9 + 8	2 + 9	8 + 6	3 + 7	9 + 5
3 + 5	5 + 5	6 + 3	0 + 5	4 + 9	8 + 1
8 + 7	1 + 6	2 + 6	1 + 7	0 + 2	5 + 1

39

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Subtraction Fluency (Grades K+)

"Now we are going to do the same thing, but with subtraction problems."

3 – 2	3 – 1	5 – 1	5 – 2	2 – 1	4 – 2
5 – 4	4 – 3	4 – 1	6 – 2	5 – 3	7 – 4
9 – 2	6 – 4	9 – 6	8 – 7	6 – 5	7 – 2
8 – 4	7 – 6	8 – 2	6 – 0	1 – 1	8 – 3
4 – 4	6 – 3	9 – 4	8 – 0	0 – 0	7 – 1
10 – 6	2 – 0	9 – 1	8 – 5	6 – 1	9 – 3
9 – 5	1 – 0	7 – 5	6 – 6	10 – 7	8 – 6
3 – 0	3 – 3	8 – 1	9 – 8	10 – 5	7 – 3

40

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Multiplication Fluency (Grades 3+)

"Now we are going to do the same thing, but with multiplication problems."

1 × 1	2 × 2	1 × 8	0 × 9	6 × 1	1 × 3
7 × 0	1 × 4	4 × 2	2 × 3	3 × 1	4 × 4
2 × 6	5 × 1	8 × 0	7 × 4	6 × 3	1 × 5
1 × 0	7 × 1	8 × 4	8 × 6	9 × 4	5 × 7
7 × 9	7 × 3	4 × 5	0 × 0	6 × 5	8 × 8
6 × 4	4 × 7	5 × 3	3 × 8	6 × 7	3 × 6
2 × 5	9 × 3	9 × 1	5 × 2	3 × 2	8 × 7
3 × 3	5 × 8	3 × 4	6 × 9	3 × 5	8 × 2

41

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Division Fluency (Grades 3+)

"Now we are going to do the same thing, but with division problems."

1 ÷ 1	10 ÷ 2	3 ÷ 1	2 ÷ 1	12 ÷ 2	3 ÷ 3
20 ÷ 4	2 ÷ 2	14 ÷ 2	12 ÷ 6	16 ÷ 4	8 ÷ 4
9 ÷ 1	15 ÷ 3	8 ÷ 2	6 ÷ 1	18 ÷ 3	4 ÷ 4
45 ÷ 9	36 ÷ 6	27 ÷ 3	18 ÷ 2	49 ÷ 7	12 ÷ 4
36 ÷ 4	14 ÷ 7	18 ÷ 6	72 ÷ 8	63 ÷ 9	32 ÷ 4
6 ÷ 6	15 ÷ 5	36 ÷ 9	21 ÷ 7	24 ÷ 4	81 ÷ 9
35 ÷ 5	72 ÷ 9	30 ÷ 5	16 ÷ 2	4 ÷ 2	56 ÷ 8
54 ÷ 6	42 ÷ 7	30 ÷ 6	7 ÷ 7	8 ÷ 8	24 ÷ 6

42

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Linguistic Math Concepts (All Grades)

"I am going to ask you questions about specific math terms. Please select the best answers from the choices."

"Which one has the fewest stars?"

3rd – 8th : In the problem 10 – 3 = 7, what is the 7?

A. Sum; B. Difference; C. Factor; or D. Tens place

43

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Semantic Index

1. Spatial Memory - 32 items
2. Equation Building – 30 items
3. Perceptual Estimation – 26 items
4. Number Comparison – Timed subtest: 60 seconds
5. Addition Knowledge – Timed subtest: 60 seconds
6. Subtraction Knowledge – Timed subtest: 60 seconds
7. Multiplication Knowledge – Timed subtest: 60 seconds
8. Division Knowledge – Timed subtest: 60 seconds

44

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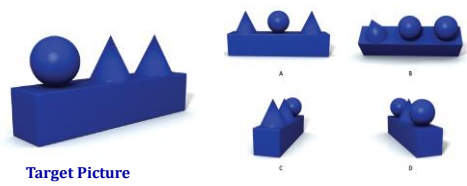
Spatial Memory (All Grades)

"I'm going to briefly show you a picture (2 sec) and then ask you to find it again (5 sec). The picture may be turned or rotated in a new way."

Sample Item



Target Picture

45

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Equation Building (Grades 3+)

"I'm going to read some math word problems, and I want you to select the equation you would use to solve each problem."

Sample Item

Alex did 34 push-ups in gym class today. Henry did 6 more push-ups than Alex did. Which equation shows how many push-ups Henry did?

A 34×6
C $34 \div 6$
B $34 + 6$
D $34 - 6$

46

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Perceptual Estimation (All Grades)

Sample Item (1-5)

"I'm going to show you some containers filled with different items. I want you to tell me which container has more items <u>without counting them</u>."

(2 sec to respond)

47

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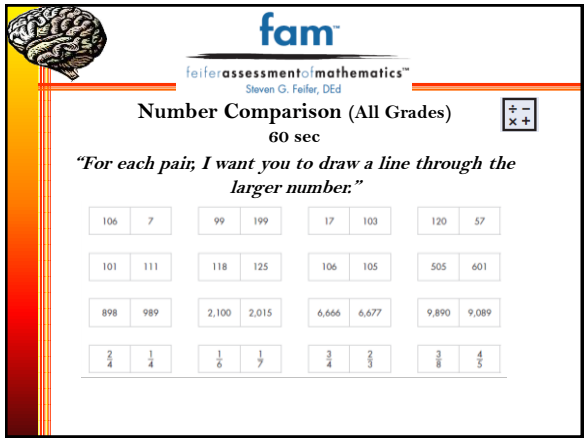
Perceptual Estimation (All Grades)

Items 6-26

"I'm going to show you a picture with the exact number of items written below it. Use this picture and number as clues to help you figure out about how many items are in the picture next to it <u>without counting them</u>."

Sample Item

48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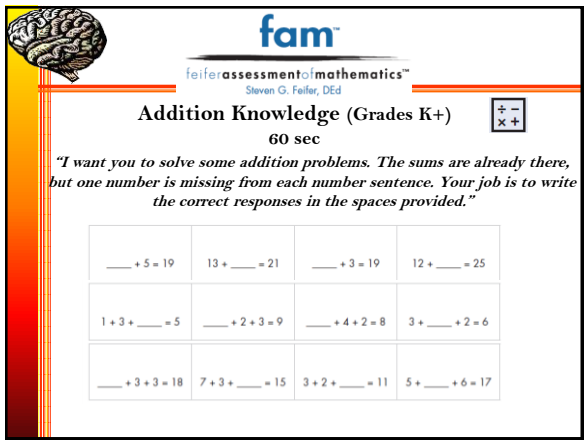
Number Comparison (All Grades)
60 sec
"For each pair, I want you to draw a line through the larger number."
106 7
99 199
17 103
120 57
101 111
118 125
106 105
505 601
898 989
2,100 2,015
6,666 6,677
9,890 9,089
2/4 1/4
1/6 1/7
3/4 2/3
3/8 4/5

49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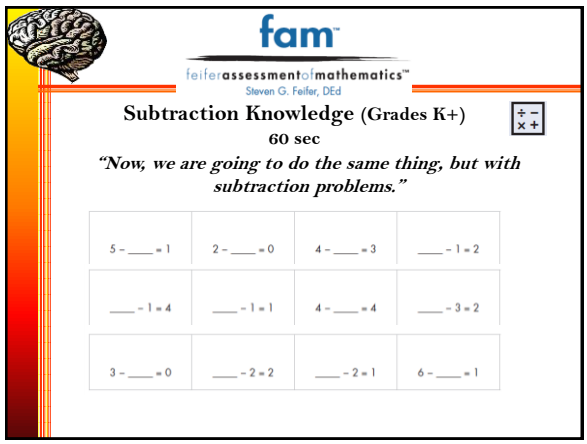
Addition Knowledge (Grades K+)
60 sec
"I want you to solve some addition problems. The sums are already there, but one number is missing from each number sentence. Your job is to write the correct responses in the spaces provided."
___ + 5 = 19
13 + ___ = 21
___ + 3 = 19
12 + ___ = 25
1 + 3 + ___ = 5
___ + 2 + 3 = 9
___ + 4 + 2 = 8
3 + ___ + 2 = 6
___ + 3 + 3 = 18
7 + 3 + ___ = 15
3 + 2 + ___ = 11
5 + ___ + 6 = 17

50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Subtraction Knowledge (Grades K+)
60 sec
"Now, we are going to do the same thing, but with subtraction problems."
5 - ___ = 1
2 - ___ = 0
4 - ___ = 3
___ - 1 = 2
___ - 1 = 4
___ - 1 = 1
4 - ___ = 4
___ - 3 = 2
3 - ___ = 0
___ - 2 = 2
___ - 2 = 1
6 - ___ = 1

51

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Multiplication Knowledge (Grades 3+)

60 sec

"Now, we are going to do the same thing, but with multiplication problems."

2 × ___ = 4	___ × 1 = 1	1 × ___ = 4	___ × 5 = 10
3 × ___ = 12	___ × 2 = 12	___ × 3 = 15	___ × 4 = 16
___ × 2 = 20	6 × ___ = 36	___ × 3 = 24	7 × ___ = 35
10 × ___ = 40	8 × ___ = 48	1 × ___ = 0	___ × 6 = 54

52

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Division Knowledge (Grades 3+)

60 sec

"Now, we are going to do the same thing, but with division problems."

15 ÷ ___ = 5	___ ÷ 4 = 4	___ ÷ 6 = 5	___ ÷ 4 = 7
30 ÷ ___ = 3	___ ÷ 7 = 5	___ ÷ 9 = 8	42 ÷ ___ = 6
27 ÷ ___ = 3	63 ÷ ___ = 9	___ ÷ 8 = 11	144 ÷ ___ = 12
___ ÷ 11 = 9	___ ÷ 9 = 7	___ ÷ 12 = 4	32 ÷ ___ = 8

53

Key Observations

- Skipping lines
- Uneven tempo during fluency tasks
- Sacrificing accuracy for speed
- Sacrificing speed for accuracy
- Finger counting
- Using the "ones" strategy
- Dropping back and counting forward
- Verbal counting
- Working out answers

54

Interpreting the FAM

1. **Determine the FAM Total Index Score**

2. **Determine the FAM Procedural, Verbal, and Semantic Index Scores and compare these scores to the FAM Total Index score.**
   a) **Absolute Strengths and Weaknesses**
   b) **Relative Strengths and Weaknesses**
   c) **Compare each Index Score to each other.**

3. **Key Subtest Interpretations**

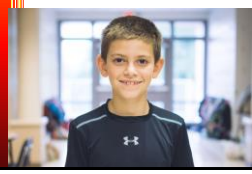
4. **Relevant behavioral observations**

* **Correlation between FAM Screening Index and FAM Total Index = .83.**

55

Kenny: 8 yrs old

- 3rd grade and struggles retaining basic math facts.
- Often fails most tests and quizzes.
- Limited conceptual understanding of math.
- Tends to count on his fingers when working.
- Reading and writing skills commensurate with age and grade level.



- No behavior or attention concerns.

56

Kenny: 8 yrs old

KTEA III Math Subtests	Standard Score	Percentile	Range
Math Concepts & Applications – the student responds orally to applied math problems involving number concepts, time, and measurement.	80	9%	Below Average
Math Computation – an untimed test requiring student to solve math equations including addition, subtraction, multiplication and division.	88	21%	Below Average
Math Fluency – the student solves as many basic problems as possible in one minute	85	16%	Below Average
KTEA III Math Composite	82	12%	Below Average

57

Case Study: Kenny

Score Summary

Page range	Subtest	Raw score	Standard score	Index standard score	Confidence interval ☐ 90% ☑ 95%	Percentile
5-6	Forward Number Count (FNC)	11	77			6
7-8	Backward Number Count (BNC) K+	9	+ 77			6
9	Numeric Capacity (NCA)	8	+ 102			55
27-28	Sequences (SEQ)	15	+ 82			12
31-32	Object Counting (OC) PK-2nd	—	+ —			—
	Procedural Index (PI)		= 338	80	72-88	9
10	Rapid Number Naming (RNN)	57	107			68
12-13	Addition Fluency (AF) K+	11	+ 89			23
14-15	Subtraction Fluency (SF) K+	7	+ 87			19
16-17	Multiplication Fluency (MF) 3rd+	6	+ 87			19
18-19	Division Fluency (DF) 3rd+	2	+ 85			16
23-26	Linguistic Math Concepts (LMC)	26	+ 100			50
	Verbal Index (VI)		= 555	90	82-98	25
11	Spatial Memory (SM)	14	98			45
20-22	Equation Building (EB) 3rd+	2	+ 80			9
29-30	Perceptual Estimation (PE)	10	+ 84			14
33	Number Comparison (NCO)	17	+ 76			5
34	Addition Knowledge (AK) K+	4	+ 71			3
35	Subtraction Knowledge (SK) K+	1	+ 74			4
36	Multiplication Knowledge (MK) 3rd+	1	+ 75			5
37	Division Knowledge (DK) 3rd+	1	+ 77			6
	Semantic Index (SI)		= 635	71	66-76	3
	PI + VI + SI = FAM Total Index (TI)		1,528	77	69-85	6

58

FAM Report Writer:
Semantic Dyscalculia

1. Math Word Walls – create classroom charts or individual desk laminates with math vocabulary terms, magnitude representations through pictures, and numeric equations and facts as a reference guide.
2. Answers Provided – administer math worksheets with the answers already provided to the equations. Half should be correct answers, and the other half are incorrect. Have the student identify all of the correct answers and verbally explain "why" the answer is correct, and draw a picture to demonstrate "why" the answer is not correct.
3. Abacus Training – Using a color-coded abacus helps to reinforce magnitude representations of numbers and develop more automatic counting skills. The beads should be color-coded and divided into two groups of five for each row.
4. Vertical number lines – attach a number line that runs vertically beside @Name's desk. This will aid in developing a better feel for spatial relationships between numbers.
5. Picture Drawing – practice drawing pictures or using a bar graph to represent numerals as well as equations to develop greater magnitude representational skills.
6. Sequence Sense – practice developing an understanding of basic number patterns and how numerals sequentially relate to one another. For instance, present a number pattern such as 3 -6 – 9 - ___ - 15.
7. Odd Number Out – present groups of numbers such as 4-16-31-64 and ask "*which number does not belong and why*" to develop better numeric pattern recognition skills.

59

FAM Report Writer:
Websites and Apps

1. Khan Academy *https://www.khanacademy.org/*
The Khan Academy is full of helpful videos explaining a variety of math topics, as well as other academic topics. There is an initial pre-test upon first logging in that determines appropriate starting levels.

2. Hooda Math *http://www.hoodamath.com/*
Hooda Math is geared toward helping kids practice and learn through games and computer activities. Specific math topics include addition, subtraction, multiplication, addition, geometry, basic physics, fractions, integers, and algebra.

3. Estimation 180 *http://www.estimation180.com*
Estimation 180 is a website that presents a new estimation challenge every day of the school year.

4. Patrick JMT *http://patrickjmt.com/*
The "JMT" in Patrick JMT stands for "Just Math Tutorials." This website has clear math videos on a variety of math related topics.

5. Cool Math 4 Kids *https://www.coolmath4kids.com*
A highly entertaining and interactive website offering games, activities, puzzles, and challenges for a variety of math topics for children.

60

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- Based upon a neurocognitive theory of brain functioning.
- Use in conjunction with an academic achievement test.
- Saves time because there is no need for cross battery math assessment, since processing is built into the test.
- Explains WHY a student is having math difficulty, not just WHERE the student is achieving.
- Directly informs intervention decision making.
- Can diagnose, screen, or use for progress monitoring.
- Puts the "I" back in IEP's!!!

61

Let's Stay Connected!

Steven G. Feifer, D.Ed., ABSNP
Licensed Psychologist

Workshops: feifer@comcast.net

Books: www.schoolneuropsychpress.com
@schoolneuropsychpress

Tests: FAR- 2015 FAM- 2016 FAW - 2020
Psychological Assessment Resources

62