Optimizing Practice Opportunities in Mathematics to Help Students with Dyscalculia Retain Essential Concepts and Skills

High Intensity Instructional Techniques (HIIT) 4 Math

DLD@Night

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Focus on Retention

- Designing instruction to help students of all skill levels achieve success in mathematics.
- Cognitive Process of Retention
- Intensifying Retention Activities
  1. **Interleaving Practice Format (IPF)**

1

Retention

- Teaching new content is a major part of our job, but also helping students RETAIN (remember) content is essential.
  - Nature of mathematics interconnected content
  - New content often builds from previous content
- Teaching is essentially dominated by our goal of putting information "IN"
- More effective techniques for helping students take information "OUT" is ESSENTIAL

2

Guiding Questions

- Is retention a major challenge for you and your students?
- Do students seem to demonstrate they've learned something only to forget it when it comes up again?

3

Learner Characteristics

- **Strategic Learners**
  - Able to analyze a problem and develop a plan
  - Able to organize multiple goals and switch flexibly from simple to more complicated goals
  - Access their background knowledge and apply it to novel tasks
  - Develop new organizational or procedural strategies as the task becomes more complex
  - Use effective self-regulated strategies while completing a task
  - Attribute high grades to their hard work and good study habits
  - Review the task-oriented-goals and determine whether they have been met

http://iris.peabody.vanderbilt.edu/srs/chalcycle.htm

4

Learner Characteristics

- **Non-Strategic Learners**
  - Unorganized, impulsive, unaware of where to begin an assignment
  - Unaware of possible steps to break the problem into a manageable task, possibly due to the magnitude of the task
  - Exhibit problems with memory
  - Unable to focus on a task
  - Lack persistence
  - Experience feelings of frustration, failure, or anxiety
  - Attribute failure to uncontrollable factors (e.g., luck, teacher's instructional style)

http://iris.peabody.vanderbilt.edu/srs/chalcycle.htm

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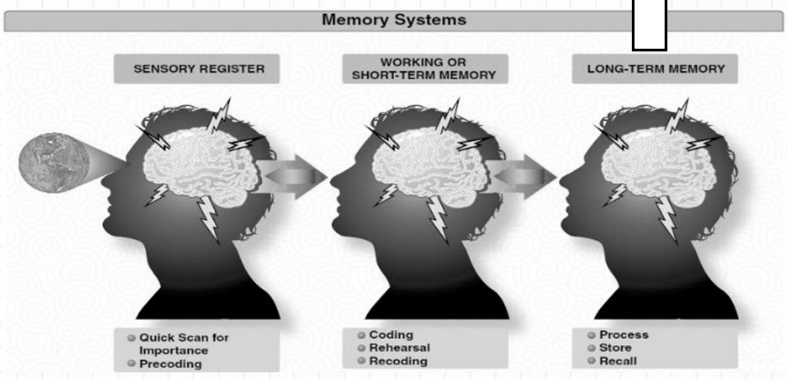
Learner Characteristics

- task
  - Exhibit problems with memory
    - **Short** and **long term retention**



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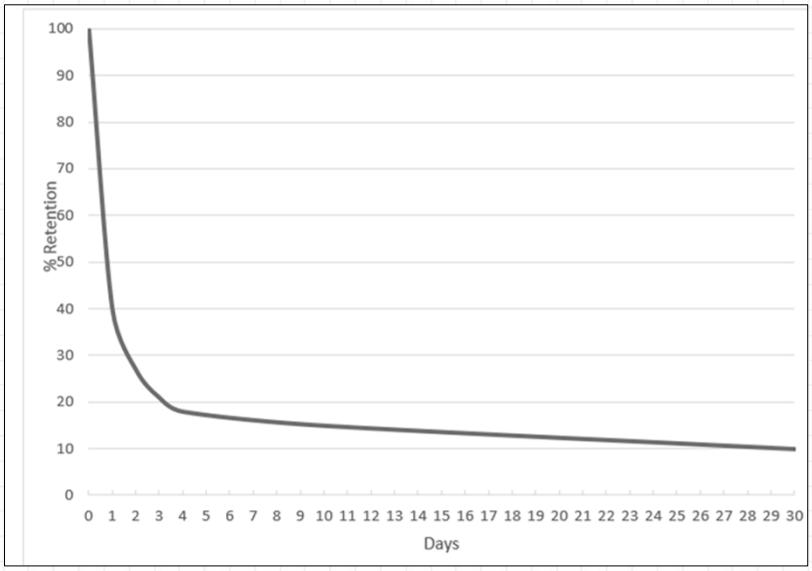
Forgetting Curve (Hughes, Riccomini, & Morris 2019)



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Breakout Activity

- Take a moment and think about the activities you do that are focused on reviewing previously taught math concepts and skills.
  - Basically any activity that you might call a "review."
- Common Activities:

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Consider this…

- Deficits in data, does not necessarily indicate students didn't learn it the first time!
  - Learning without retention is pointless!
- We are "not really" being evaluated on what we **"teach students",** we are being evaluated on what our students are able to "**REMEMBER**."

9

Purposes of Practice

- Identifying the "purpose" of a practice activity is critical to achieving the desired outcome
- Mismatch of **purpose** and **structure** can negate the entire activity…..inefficient use of time.
  - Allocated time is important but not sufficient
- Focus on the **PURPOSE** of practice opportunities in both core and intervention.
  - Is the purpose acquisition…or initial learning?
  - Is the purpose retention….cumulative review?
  - Is the purpose to build fluency and/or automaticity?
  - Is the purpose to promote generalization?

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  - Is the purpose to promote generalization?

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•Interleaving Practice Format (IPF)

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Practice Activities in Mathematics

- Take a moment and think about how the practice activities you provide students are organized.
- Focus in on the sequence of problems in terms of how the math problems are presented?
  - Problem 1 to Problem 2 to problem 3…..

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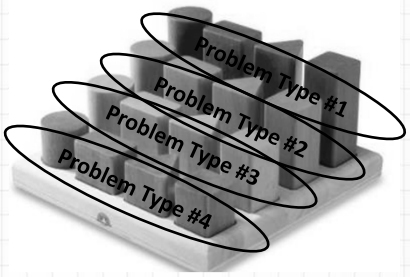
Practice Structures in Mathematics

BLOCKED (MASS) Structure:

- Problems of the same type are sequence consecutively
  - aaaaaaaaaaaaaaaaaa
  - aaaa, bbbb, cccc, dddd



- **Purpose:**
  - Promotes initial acquisition of understanding and accuracy
- **IMPORTANCE:**
  - Initially VERY IMPORTANT

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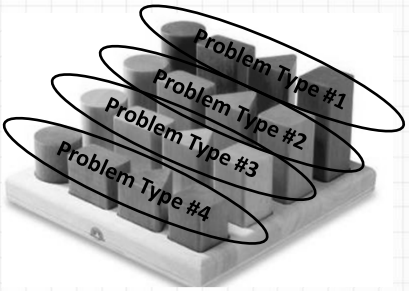
Practice Structures in Mathematics

WARNING!
BLOCKED Structure DOES NOT PROMOTE, FACILITATE, AND/OR INCREASE RETENTION



Blocked Practice =

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Practice Structures in Mathematics

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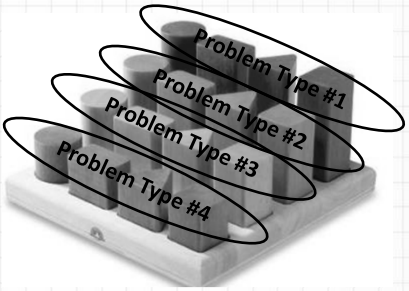

Blocked Practice =

Blocked Practice plays a very important role in initial stages of practice, so it can not be omitted

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Example of Blocked Practice

Find the LCM of the following numbers by listing their multiples.

1) 4: ____, ____, ____, ____

6: ____, ____, ____, ____
LCM= ____

2) 6: ____, ____, ____, ____, ____, ____

9: ____, ____, ____, ____, ____, ____
LCM = ____

3) 3: ____, ____, ____, ____, ____, ____

8: ____, ____, ____, ____, ____, ____
LCM = ____

Same type of problem sequence consecutively (Problem Type A)

Find the product by using the "zero rule"

4) 500 x 30 = ____
5) 70 x 4 = ____
6) 2,000 x 600 = ____

Same type of problem sequence consecutively (Problem Type B)

Find the standard form ("*the answer*") when given the base and exponent

7) 7^2 = ____ = ____
8) 6^3 = ____ = ____
9) 5^3 = ____ = ____

Same type of problem sequence consecutively (Problem Type C)

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Example of Blocked Practice

Math Mixed Review Part 1
Flying Through Fourth Grade

Directions: Use your favorite addition strategy to find the sum.

1.	2.	3.	4.	5.
142	1,452	62	25,102	92
+158	+ 371	+ 39	+ 551	+ 49

Directions: Use your favorite subtraction strategy to find the difference.

6.	7.	8.	9.	10.
190	30	524	5,246	42,595
- 165	- 12	- 22	- 145	- 2,371

Directions: Write the factors for each number. Then, decide whether the number is prime or composite.

Numbers	Factors	Prime or Composite?
11) 21		
12) 30		
13) 19		

Now, write the first five multiples of the number 7: ____

Directions: Solve the word problem. Make sure to show your work in each section.

Gavin is a quiltmaker. He uses 5 yards of material to make one square quilt and 7 yards of material to make one rectangular quilt. How many yards of material would Gavin need to make 6 square quilts and 6 rectangular quilts?

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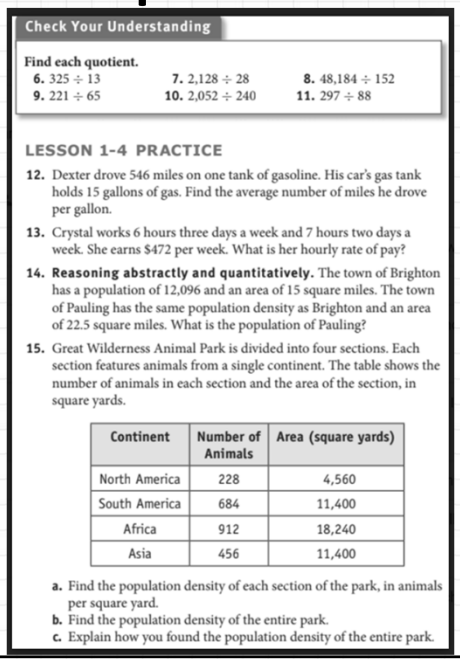
Example of Blocked Practice



Check Your Understanding

Find each quotient.

6. 325 ÷ 13 **7.** 2,128 ÷ 28 **8.** 48,184 ÷ 152
9. 221 ÷ 65 **10.** 2,052 ÷ 240 **11.** 297 ÷ 88

LESSON 1-4 PRACTICE

12. Dexter drove 546 miles on one tank of gasoline. His car's gas tank holds 15 gallons of gas. Find the average number of miles he drove per gallon.

13. Crystal works 6 hours three days a week and 7 hours two days a week. She earns $472 per week. What is her hourly rate of pay?

14. Reasoning abstractly and quantitatively. The town of Brighton has a population of 12,096 and an area of 15 square miles. The town of Pauling has the same population density as Brighton and an area of 22.5 square miles. What is the population of Pauling?

15. Great Wilderness Animal Park is divided into four sections. Each section features animals from a single continent. The table shows the number of animals in each section and the area of the section, in square yards.

Continent	Number of Animals	Area (square yards)
North America	228	4,560
South America	684	11,400
Africa	912	18,240
Asia	456	11,400

a. Find the population density of each section of the park, in animals per square yard.
b. Find the population density of the entire park.
c. Explain how you found the population density of the entire park.

Why is this an example of blocked practice?

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What is the purpose (or should be) of this practice sheet?

What will this blocked practice likely not help?

Is this a "bad" practice sheet?

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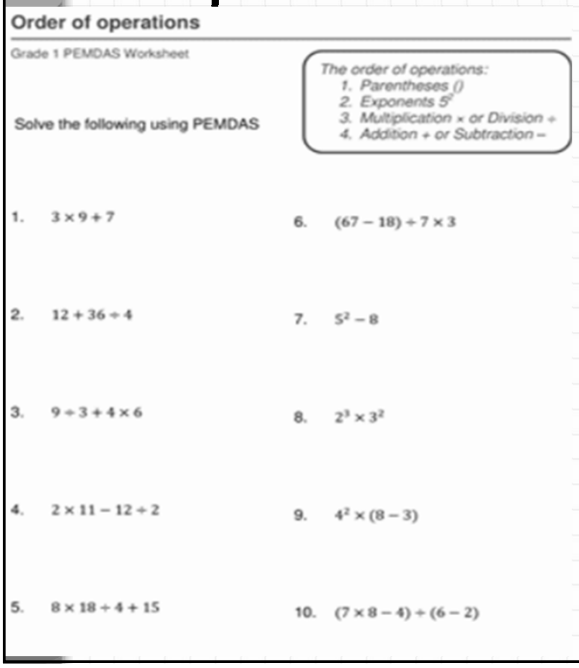
Example of Blocked Practice



Order of operations

Grade 1 PEMDAS Worksheet

The order of operations:
1. Parentheses ()
2. Exponents 5^0
3. Multiplication × or Division ÷
4. Addition + or Subtraction –

Solve the following using PEMDAS

1. $3 \times 9 + 7$
2. $12 + 36 \div 4$
3. $9 \div 3 + 4 \times 6$
4. $2 \times 11 - 12 \div 2$
5. $8 \times 18 \div 4 + 15$
6. $(67 - 18) \div 7 \times 3$
7. $5^2 - 8$
8. $2^3 \times 3^2$
9. $4^2 \times (8 - 3)$
10. $(7 \times 8 - 4) \div (6 - 2)$

Why is this an example of blocked practice?

What is the purpose (or should be) of this practice sheet?

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Example of Blo… Practice

Bored Brain Syndrome

Find the LCM of the following numbers by listing

1) 4: ____, ____, ____, ____
   6: ____, ____, ____
   LCM= ____
2) 6: ____

…e of problem
…ice consecutively
…oblem Type A)

Find the pr…
4) 500 x 30
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6) 2,000 x 600 = ____

Same… …e
cons… …)

Find the standard form ("*the answer*") when given the base and exponent
7) 7^2 = _____ = ____
8) 6^3 = _____ = _____
9) 5^3 = _____ = _____

Same… …e
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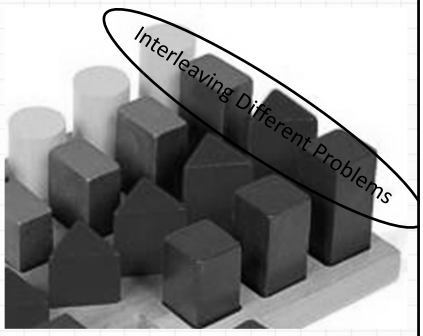
Practice Structure in Mathematics

Interleaving Practice Format (IPF):

- Problems of the same type are sequence in a mixed format (NOT Consecutively)
- Abc abc abc
- Abcd, abcd, abcd



- **Purpose:**
  - Promotes long term **RETENTION** (DURABLE LEARNING)
- **IMPORTANCE:**
  - VITAL
  - Rarely occurs

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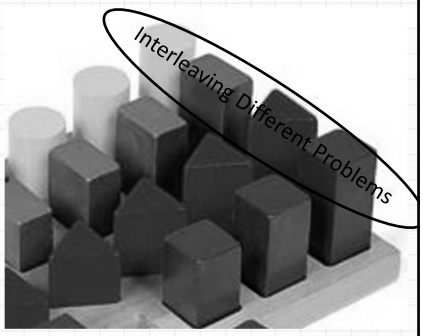

- **Purpose:**
  - Promotes long term **RETENTION** (DURABLE LEARNING)

- **IMPORTANCE:**
  - VITAL
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Interleaving Practice Format

- **Mixing it up….dissimilar problems**

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Example of IPF

Find the LCM of the following numbers by listing their multiples.
Find the product by using the "zero trick."
Find the standard form ("*the answer*") when given the base and exponent

Directions for 3 problem Types

1) 4: _____, _____, _____, _____
6: _____, _____, _____, _____
LCM= _____

Problem Type A

2) 70 x 4 = _____

Problem Type B

3) 7^2 = _____ = _____

Problem Type C

A, B, C pattern continues 3 to 4 more times for a total of 9 to 12 Problems

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Name: _____

IPF Practice

1) How long is the pencil?

_____ centimeters

2) Is 57 greater than (>) or less than (<) 118?

57 ☐ 118

3) Solve the problem.

32+5= _____

- Problem type A:
  - Measurement
- Problem Type B:
  - Comparing numbers
- Problem Type C:
  - Solve

- Patterns repeats 3 additional times for 9 total problems

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1) 568

a. What is the digit in the hundreds place? _____

b. What is the digit in the tens place? _____

c. What is the digit in the ones place? _____

2) What is the time on the analog clock?

_____

3) Is 112 odd or even? _____

IPF Practice

- Problem type A:
  - Rounding
- Problem Type B:
  - Reading a clock
- Problem Type C:
  - Odd or Even

- Patterns repeats 3 additional times for 9 total problems

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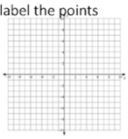
IPF #1

1. Add the fractions $\frac{7}{12} + \frac{1}{18}$

2. Simplify the expression $(5 + 2) \div 9$

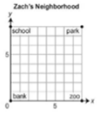
3. Plot and label the points
A.(4,6)
B.(7,2)
C.(3,0)



4. Add the fractions $\frac{2}{5} + \frac{1}{10}$

5. Simplify the expression $7(3) + 7 - 2$

6. Answer the following question about the graph

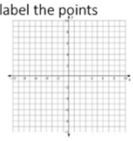


Which location is on the x axis, but not the y axis of Zach's Neighborhood Map?

7. Add the fractions $\frac{3}{5} + \frac{3}{8}$

8. Simplify the expression $(20 - 4) \div (3 + 1)$

9. Plot and label the points
A.(0,5)
B.(2,9)
C.(4,4)



IPF Example

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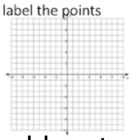

Problem type A:
- Adding Fractions

Problem type B:
- Simplify an Expression

Problem type C
- graphing

4. Add the fractions $\frac{2}{5} + \frac{1}{10}$

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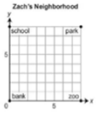

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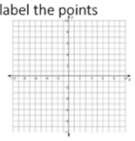

IPF Example

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IPF Practice as Warm-up Whole Group Activity

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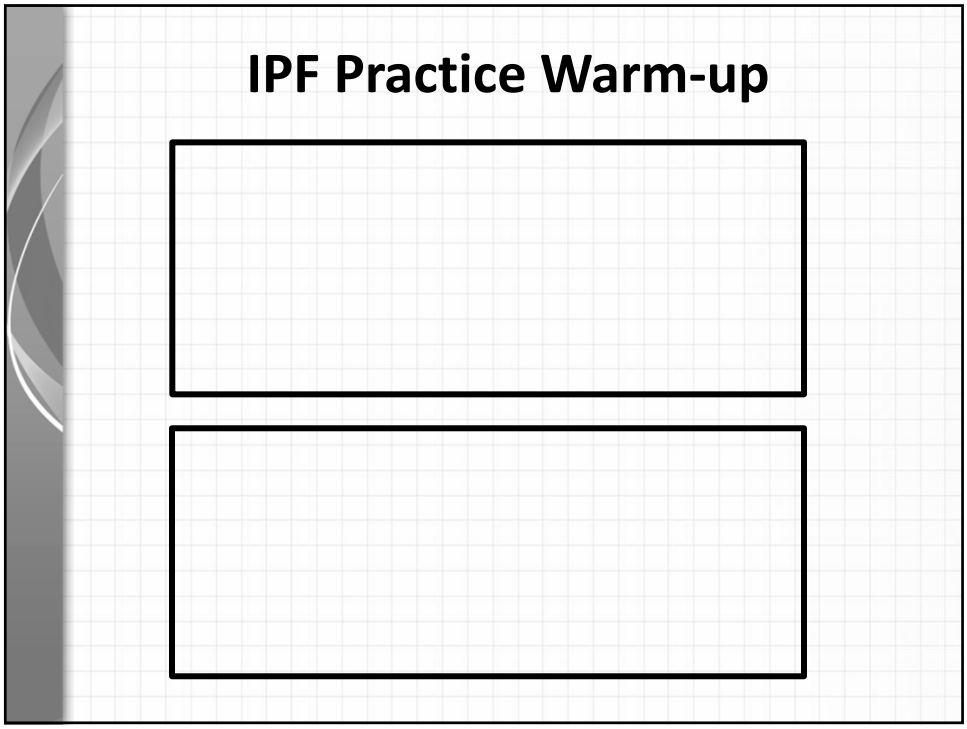

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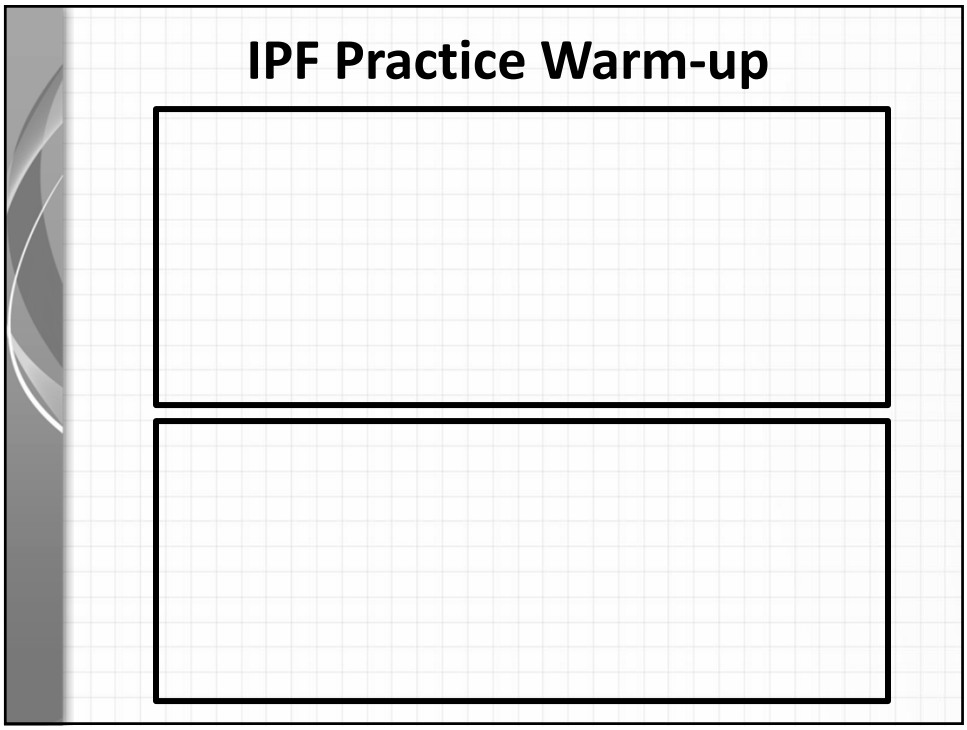

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IPF Practice Warm-up

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Interleaving Practice Format (IPF)

- Interleaving practice format (IPF) is a structure applied to practice activities to improve long term learning outcomes.
  - Produces "durable" learning
- IPF involves the **intentional mixing-up** of items within the same practice session
  - abc abc abc OR abcd abcd abcd abcd
  - Much more effective than blocking practice
  - **Blocking** design groups similar problems together (aaaaaaa bbbbbbbb ccccc)

Rohrer (2012); Rohrer, Dedrick, and Stershic (2014); Taylor and Rohrer (2010)

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Interleaving Practice Format (IPF)

- Interleaving practice format (IPF) results in much longer learning
  - Students retain information and improve as time passes
- Why does the mixed sequence of problems produce much longer retention?

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Example of IPF

Find the LCM of the following numbers by listing
Find the product by using the "zero trick."
Find the standard form ("*the answer*") when

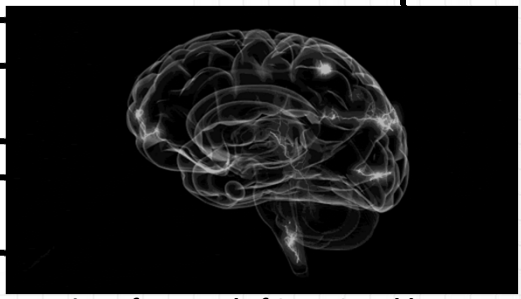
Directions for 3 problem Types

1) 4: _____, _____,
6: _____,
LC

Problem Type A

3) 7^2 = _____ = _____

Attentive Brain



A, B, C pattern continues 3 to 4 more times for a total of 9 to 12 Problems

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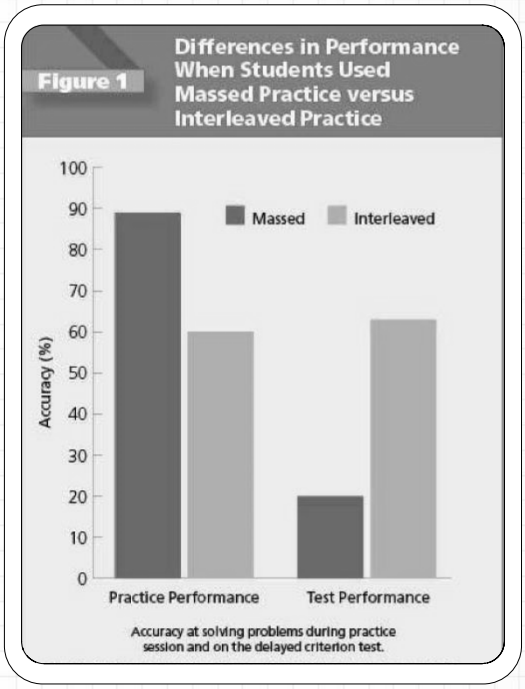
Massed Practice compared to Interleaved Practice.

Good initially….but a HUGE Difference on TEST



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Interleaving Practice Format (IPF)

Why does IFP work?

- The blocking structure does not require deeper and careful processing
  - Students recognize the strategy and just blindly apply it because they know in advance
  - No retrieval is necessary, the solution strategy is only held in Short term working memory
- IPF requires the students to think more deeply about each problem because it is different
  - Requires students retrieve different strategies from long term memory
  - Forces students to "pay attention" to the problem features at same time they are retrieving the appropriate solution strategy

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Interleaving Practice Format (IPF)

Considerations

1. Blocking is important in the initial stages of learning a new concept/skill
   1. Begin with blocking practice, but then move to IPF once students have "some" familiarity with new topic
2. Students prefer blocking structured practice even though the research results are crystal clear in terms of improved performance with IPF.

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Interleaving Practice Format (IPF)

Planning Guidelines

Planning and Implementation

1. Identify problem types by unit or month
   - Map out skills by month or unit
2. Arrange the problem types in an alternating sequence so the problems are dissimilar
   - Abc abc abc OR abc abc abc abc
   - Abcd abcd abcd
   - 9-12 problems per IPF Opportunity
     - Consider grade of students and problem type

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Interleaving Practice Format (IPF)

Planning Guidelines

Planning and Implementation

1. Identify problem types by unit or month
   - Map out skills by month or chapter/unit

Month	Skills	IPF Groups	Date
		3 or 4 skills	
August	1. 2. 3. 4. 5. 6.		
September	1. 2. 3. 4. 5. 6.		
October	1. 2. 3. 4.		

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Interleaving Practice Format (IPF)

Planning Guidelines

Planning and Implementation

1. Identify problem types by unit or month
   - Map out skills by month or chapter/unit

Step 1: Grade level teams identify essentials skills and concepts

Step 2: Grade level teams decide which problems are dissimilar to group together

Step 3: Schedule IPF activities

Month	Skills	IPF Groups	Date
		3 or 4 skills	
August	1. 2. 3. 4. 5. 6.		
September	1. 2. 3. 4. 5. 6.		
October	1. 2. 3. 4.		

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Interleaving Practice Format (IPF)

Planning Guidelines

Problem Arrangement Considerations:

- 9-12 problems
  - Too many problems will defeat the purpose
- Consider the difficulty level of the problems
  - Basic, Moderate, Advanced
  - Do not group 3 advanced problems together on an IPF
  - Consider mixing the problem levels
    - Moderate Basic Moderate
    - Basic Advanced Basic
    - Moderate Advanced basic
- Biggest questions revolve around what is considered "DISSIMILAR" problems
  - Use your professional judgment

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Interleaving Practice Format (IPF)

Planning Guidelines

Planning and Implementation

3. Provide IPF opportunities 2 to 3 times per month
   - 20-minute IPF practice sessions
   - Assign on Monday and collect or go over on Friday
4. Provide regular IPF activities across the school year
   - Homework or in class or computer practice
     - Homework: Advantage: No class time used
     - Homework Disadvantage- Not all students will complete and can't help
     - In class-Disadvantage—Use up class time
     - In class-Advantage-Provide help and increases student completion

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IPF Quiz

- **List the Non-Negotiable Key Ingredients**

- **Negotiable Key Ingredients**

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IPF Implementation Checklist

- **Non-Negotiable Key Ingredients**
  - Sequence must be mixed and follow the sequence
    - abc, abc, abc OR abc abc abc abc OR abcd abcd abcd
  - Problems must be dissimilar in process
    - Not the same process
  - Develop IPF Sheets in sets of 9 to 12 problems
  - Provide IPF opportunities at least 2-3 times per month
  - Blocked practice must still occur in the initial stages
- **Negotiable Key Ingredients**
  - Homework, in-class, computer practice, games
  - The problems grouped together
    - Must be dissimilar in process

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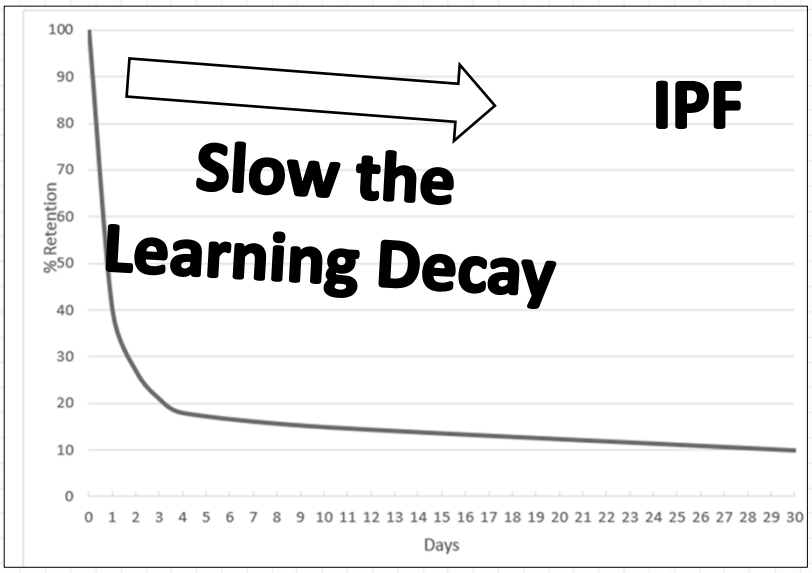
Purpose of IPF



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Summary Retention and IPF

- More purposeful and carefully designed practice opportunities are an essential element to intensifying retention activities
- Blocked practice is important in initial learning; but is not sufficient to enhance retention
  - Bored Brain Syndrome
- Interleaved Practice Format is essential to boost and enhance retention of important mathematical concepts and skills
  - Mix it up!!!!
  - Attentive Brain

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Teacher Resource

- www.retrievalpractice.org
  - Click on "Download our Retrieval Practice Guide)
  - Download the **INTERLEAVING GUIDE**

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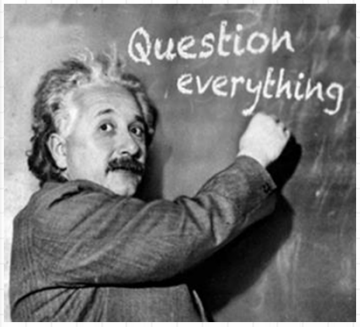
Retention and IPF

- What are your questions or concerns related to the Retention in Mathematics and the IPF strategy?



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QUESTIONS?

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