Lasting Learning Through Interleaving:
A Powerful Strategy for All Levels of Math

The Palmetto Education Summit
June 15-17, 2026

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Session Focus

- Designing instruction to help students of all skill levels achieve success in mathematics.
  - Specially Designed Instruction (SDI) activities
- Cognitive Process of Retention
- Intensifying Retention Activities
  1. Blocked Practice
  2. Interleaving Practice Format (IPF)
  3. Planning and Implementation of IPF Activities
- Summary and Questions

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Key Considerations

1. What strategies or activities are you currently using to help students remember the content you're teaching?
2. How much instructional time do you typically devote to these activities?
3. As we explore cognitive science-based techniques for retention, how might you adjust your current practices to better align with what the research says about memory and learning?

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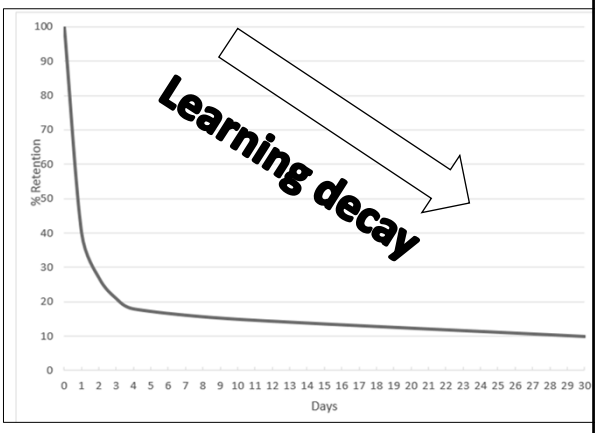
How Fast do "WE" Forget?

- Learning loss happens much faster than most educators realize.
- This rapid decline is especially concerning for students with disabilities.
- To slow this decay, we need to incorporate more **purposeful and carefully designed practice**.
- By doing so, **teachers can flatten the forgetting curve** and significantly boost long-term retention.

Forgetting Curve



Ebbinghaus, 1885

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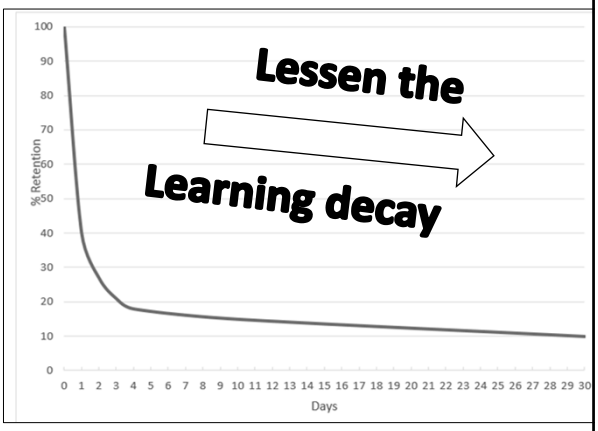

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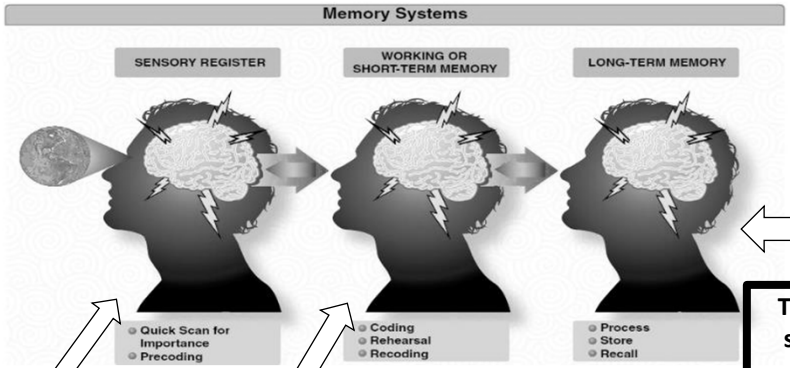
Cognitive Process of Learning



The cognitive process of supporting RETENTION (BACK END) heavily leverages the Long-Term memory part of the brain

The cognitive process of Initial learning (FRONT END) heavily leverages the Sensory Register and Working memory parts of the brain

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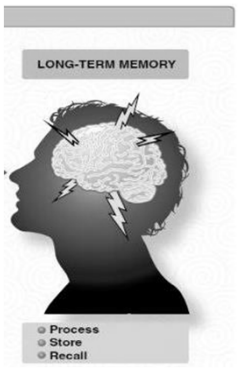
Cognitive Process of Learning

Activities that help students remember previously learned information must be designed to <u>repeatedly engage</u> the brain's <u>long-term memory systems</u>.



Activities must be designed in a way that requires students to <u>RETRIEVE</u> information <u>REPEATEDLY</u>

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How do I Boost Retention?

What are the Key Mechanisms for Retention Activities?

1. **Interleaving Practice –** Sequencing of Problems
   – Interleaving of skills vs blocking of skills
2. **Spaced Learning Over Time -** Windows of Time
   – Purposeful spacing for revisiting content is critical
3. **Practice Test Retrieval -** Free Recall paired with feedback
   – Regular and consistent recall without assistance paired with feedback in low stakes activities

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How to Plan Interleave Practice Activities?

- Best planned and implemented early and consistently during the school year
- Takes about 90 minutes of planning to develop initial IPF activities Best planned and implemented by grade level or course
  - Algebra 1 Teachers, Geometry Teachers
  - 4th grade Teachers
- Think regular routine for IPF activities
  - 2-3 IPF activities per month

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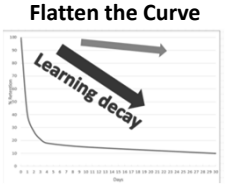
How do I Boost my Students' Retention?

What is the purpose of Practice?

- Identifying the "purpose" of a practice activity is critical to achieving the desired outcome
- Focus on the **PURPOSE** of practice 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?
- Different practice activities have different purposes



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What are Practice Structures?

- The practice *STRUCTURE* is the **sequence** or arrangement of problems students practice….
  - Structure is not the number of practice problems or how long it takes to practice
  - Or the progression---Basic to Moderate to Advanced
  - Structure is the sequence of the problems:
    - Problem 1---Problem 2—Problem 3
- What is the problem type for #1, for number #2…..

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What Practice Structures Do You Use?

- The practice *STRUCTURE* is the **sequence** or arrangement of problems student practice….
  - Review a recent practice activity that you used. It can be from your textbook, student workbook, or worksheet that you created.
  - You can also review computer practice that you have given students.
    - Look for the structure utilized….
    - What does problem #1, problem #2, problem #3….look like?
    - Describe it!

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What Practice Structures Do You Use?

- The practice *STRUCTURE* is the **sequence** or arrangement of problems student practice….
  - Most common practice structure is called **Blocked Practice!**
- If your practice is set-up that students practice the same type of problem consecutively, the structure is called **Blocked Practice!**

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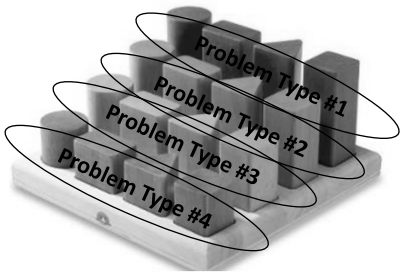
What is Blocked Practice?

BLOCKED (MASS) Structure:

- Problems of the same type are sequenced consecutively
  - aaaaaaaaaaaaaaaaaa
  - aaaa, bbbb, cccc, dddd
- **Purpose:**
  - Promotes initial acquisition of understanding and accuracy
- **IMPORTANCE:**
  - Initially VERY IMPORTANT



Blocked Practice =

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What does Blocked Practice Look Like?

90% of practice follows a blocked structure

Rohrer et al., 2020

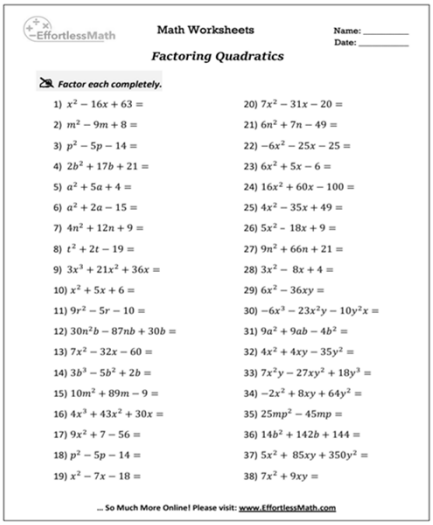
Order of operations

Grade 1 PEMDAS Worksheet

Solve the following using PEMDAS

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

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. $(7 \times 8 - 4) \div (6 - 2)$



EffortlessMath — Math Worksheets — Name: _____ Date: _____

Factoring Quadratics

Factor each completely.

1) $x^2 - 16x + 63 =$
2) $m^2 - 9m + 8 =$
3) $p^2 - 5p - 14 =$
4) $2b^2 + 17b + 21 =$
5) $a^2 + 5a + 4 =$
6) $a^2 + 2a - 15 =$
7) $4n^2 + 12n + 9 =$
8) $t^2 + 2t - 19 =$
9) $3x^3 + 21x^2 + 36x =$
10) $x^2 + 5x + 6 =$
11) $9r^2 - 5r - 10 =$
12) $30n^2b - 87nb + 30b =$
13) $7x^2 - 32x - 60 =$
14) $3b^3 - 5b^2 + 2b =$
15) $10m^2 + 89m - 9 =$
16) $4x^3 + 43x^2 + 30x =$
17) $9x^2 + 7 - 56 =$
18) $p^2 - 5p - 14 =$
19) $x^2 - 7x - 18 =$
20) $7x^2 - 31x - 20 =$
21) $6n^2 + 7n - 49 =$
22) $-6x^2 - 25x - 25 =$
23) $6x^2 + 5x - 6 =$
24) $16x^2 + 60x - 100 =$
25) $4x^2 - 35x + 49 =$
26) $5x^2 - 18x + 9 =$
27) $9n^2 + 66n + 21 =$
28) $3x^2 - 8x + 4 =$
29) $6x^2 - 36xy =$
30) $-6x^3 - 23x^2y - 10y^2x =$
31) $9a^2 + 9ab - 4b^2 =$
32) $4x^2 + 4xy - 35y^2 =$
33) $7x^2y - 27xy^2 + 18y^3 =$
34) $-2x^2 + 8xy + 64y^2 =$
35) $25mp^2 - 45mp =$
36) $14b^2 + 142b + 144 =$
37) $5x^2 + 85xy + 350y^2 =$
38) $7x^2 + 9xy =$

... So Much More Online! Please visit: www.EffortlessMath.com

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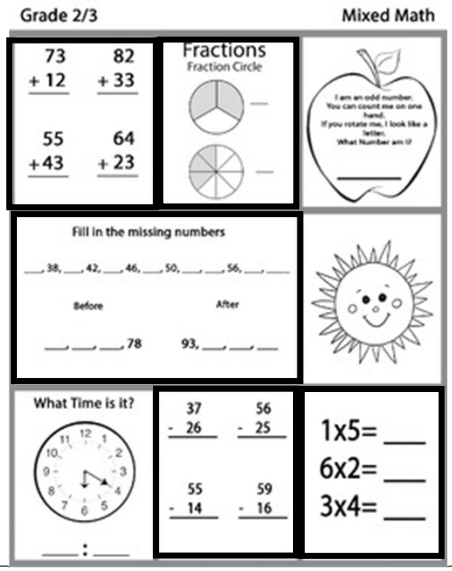
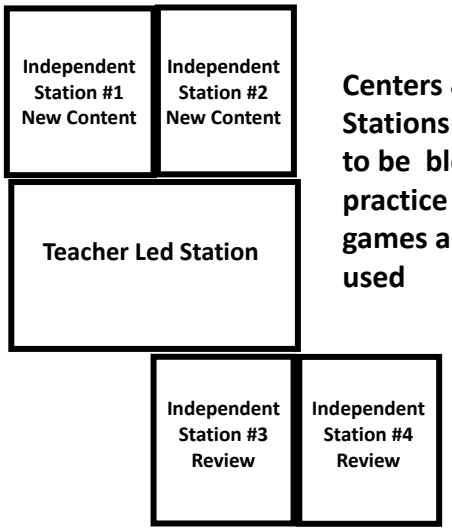
What does Blocked Practice Look Like?





Centers & Stations tend to be blocked practice if games are used

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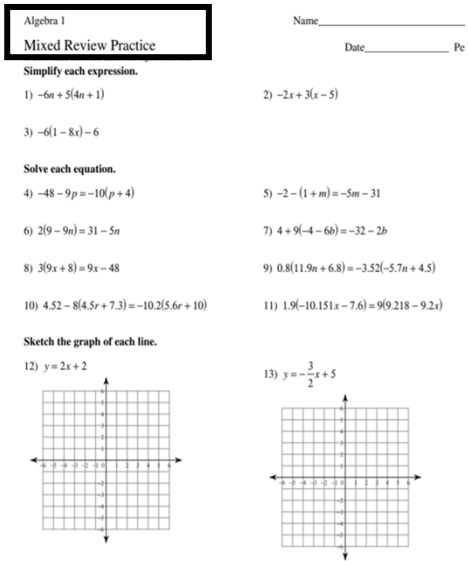
What does Blocked Practice Look Like?

Even when the purpose of practice is identified as Mixed Review it is often still blocked



Algebra 1

Mixed Review Practice

Name_____

Date_____ Pe

Simplify each expression.

1) $-6n+5(4n+1)$

2) $-2x+3(x-5)$

3) $-6(1-8x)-6$

Solve each equation.

4) $-48-9p=-10(p+4)$

5) $-2-(1+m)=-5m-31$

6) $2(9-9n)=31-5n$

7) $4+9(-4-6b)=-32-2b$

8) $3(9x+8)=9x-48$

9) $0.8(11.9n+6.8)=-3.52(-5.7n+4.5)$

10) $4.52-8(4.5r+7.3)=-10.2(5.6r+10)$

11) $1.9(-10.151x-7.6)=9(9.218-9.2x)$

Sketch the graph of each line.

12) $y=2x+2$

13) $y=-\frac{3}{2}x+5$

Why is this an example of blocked practice?

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

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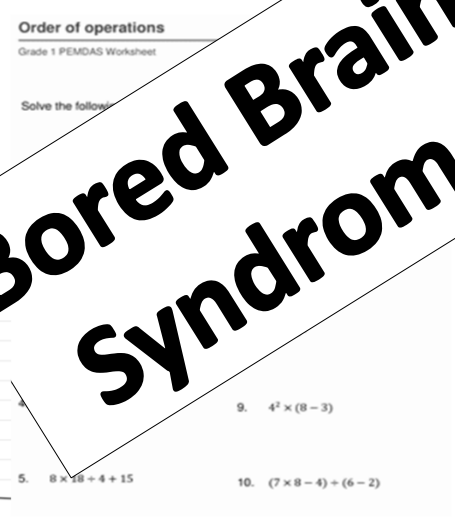
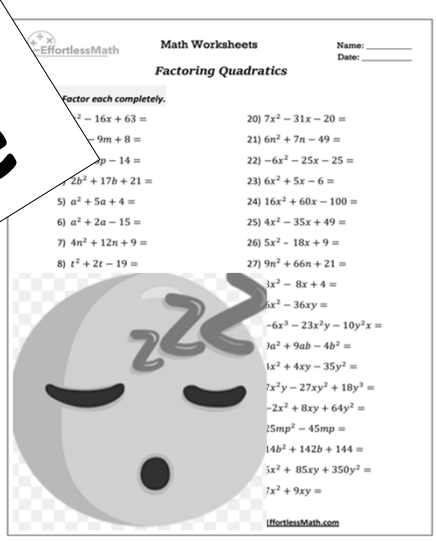
What does Blocked Practice Look Like?

90% of practice is blocked

Bored Brain Syndrome





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What do Review activities look like?

- Now that you understand the purpose and structure of blocked practice, take a moment to review your textbook, curriculum, and other materials you use for review or retention.
  - How are your review activities currently sequenced?
  - Are they presented in a **blocked format** (focused on one concept at a time)?
  - If not, how are they organized? What does the structure look like?

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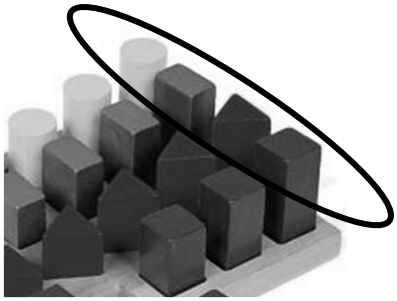
Interleaving Practice Format

Interleaving Practice Format (IPF):

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

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

- **IMPORTANCE:**
  - VITAL
  - Rarely occurs



Problem 1 is dissimilar than Problem 2 which is dissimilar than Problem 3

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Why Does IPF result in Better Retention?

This is an important point of understanding for educators. Discuss the questions below related to blocked vs interleaved practice.

1. What are the key differences in student outcomes when comparing **blocked practice** and **interleaved practice** (e.g., accuracy, retention, transfer)?
2. Why does simply changing the sequence of problems often lead to more **durable, long-term learning**?
3. What **cognitive processes** make interleaved practice more effective than blocked practice for retention?
4. **practice that results in longer retention?**

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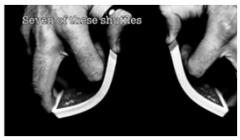
What does IPF look like?

1) How long is the pencil?

_____ centimeters



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

57 ☐ 118

3) Solve the problem.

32+5= _____

4) How long is the scissors?

_____ inches

5) Is 22 greater than (>) or less than (<) 18?

22 ☐ 18

6) Solve the problem.

12+15= _____

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What does IPF look like?

Name: _____

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? _____

4) 319
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? _____

5) What is the time on the analog clock?

_____

6) Is 57 odd or even? _____

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What does IPF look like?

Name: _____ Date: _____ Block: _____

IPF – Segment Addition, Midpoints, Angle Pairs

1. AB = 12, BC = 7. What is AC?

2. What is the midpoint between (2, 6) and (8, 8)?

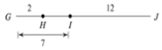
3. Solve for x.

4. AT = 3x + 1, TL = 15, and AL = 7x + 1. Solve for x.

5. What is the midpoint between (-10, 2) and (16, -28)?

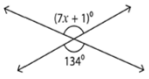
6. Solve for x.

7. What is HJ?



8. What is the midpoint of (-15, -7) and (2, 0)?

9. Solve for x and the measure of all 4 angles in the diagram.



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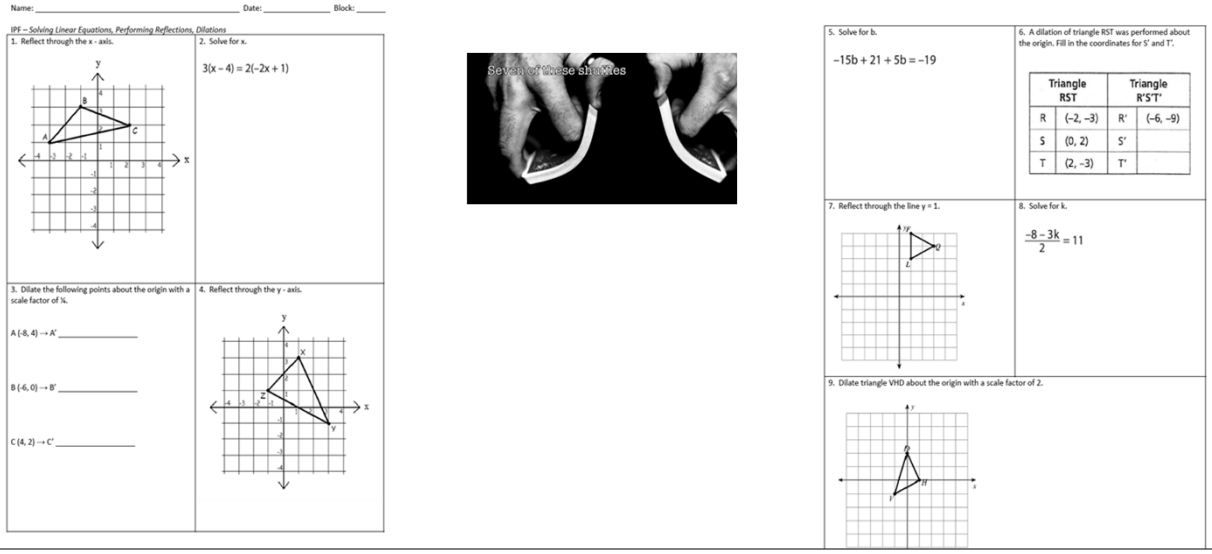
What does IPF look like?



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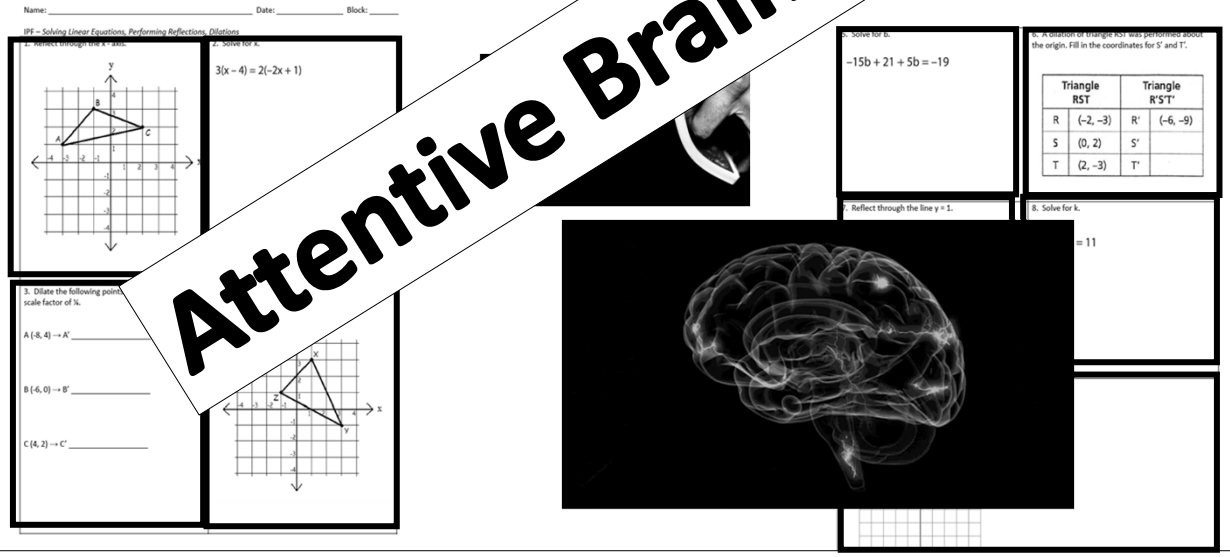
What does IPF look like?



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How much are IPF Activities Used??

- Now that you understand the purpose and structure of **Interleaved Practice**, review your textbook, curriculum, computer practice activities, and other instructional materials:
  - Are the practice activities entirely **blocked** (focusing on one skill at a time)?If so, how much?
  - Do any activities include **Interleaved Practice Format (IPF)**?
  - If so, **how frequently** is IPF used, and in what ways?

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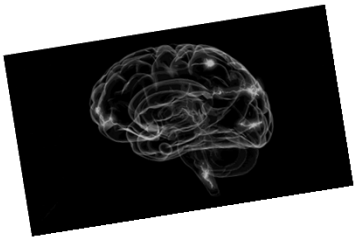
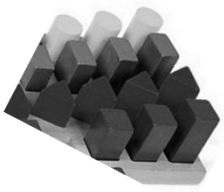
Meta-Analyses: How Good is IPF?

Hattie's Categories Visible Learning - Influences (visiblelearningmetax.com)	ES
Task Analysis	1.29
Mathematics Problem Solving	1.16
Mnemonics	0.80
Problem Solving Strategies	0.67
Math Direct-Guided Learning	0.61
Meta-cognitive strategies	0.60
Direct Instruction	0.59
Skill-Focused Content	0.58
Explicit Instruction	0.57
Setting Clear Goals	0.51
Interleaving Mixed Practice	**0.44**
Advance Organizers	0.42
Fully Worked Examples	**0.37**





Hattie, 2024:
https://www.visiblelearningmetax.com/Influences

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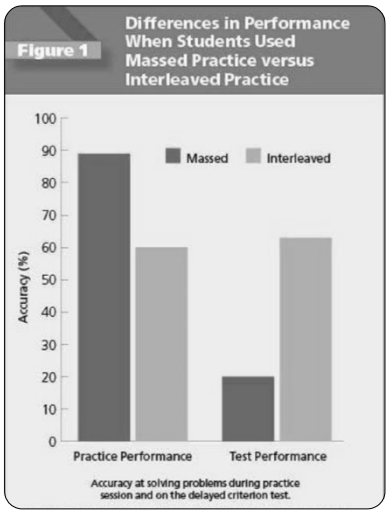
Blocked vs. Interleaved Practice Format

Massed Practice compared to Interleaved Practice:

- Initial boost in performance….but performance fades quickly.
- Performance maintained with Interleaved practice



Rohrer, Dedrick, & Agarwal, 2017

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How do I Plan & Implement IPF Activities?

Steps to Implementing IPF

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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How do I Plan & Implement IPF Activities?

Steps to Implementing IPF

Steps 1-2: Identify problem types by unit or month

- Map out skills by month or unit

Step 1: Grade level teams identify essentials skills and concepts

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

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

Step 3: Schedule IPF activities

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How do I Plan & Implement IPF Activities?

Steps to Implementing IPF

3. Provide IPF opportunities 2 to 3 times per month
   - Approximately 20 to 40 minutes for IPF practice sessions
     - Time for IPF depends on grade level
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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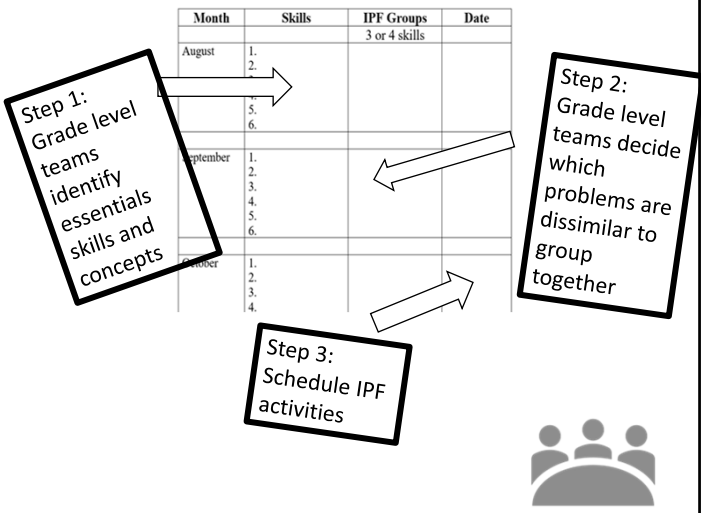
How do I Plan & Implement IPF Activities?

Start Planning IPF Activities

- **List** the key skills you teach each month.
- **Identify and discuss** which of these skills are *dissimilar* and could be combined in an IPF activity.
- **Develop a plan** to regularly implement IPF activities throughout the year.



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Expert Tips from Teachers Using IPF

- Considerations for in class IPF Activities
  - 2-3 times per month—about 15-40 minutes
  - Students can finish for homework
- Classroom Tips
  - Display answers/solutions as students work through the IPF problem set
    - After all students have finished problems 1-3; have all students check their answers
    - Repeat for problems 4-6 and then for 7-9.
  - Teacher model problems 1-3, then guided practice problems 4-6, and independent 7-9
- Should NOT Look or feel like a test situation

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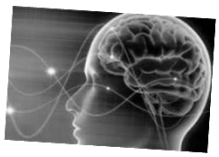
IPF Implementation Checklist

- **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
  - In class—display answers/solutions as students work through problem set
  - Should not look/feel like a test

- **Negotiable Key Ingredients**
  - Homework, in-class, computer practice, games
  - Model problems 1-3; guide practice 4-6; and independent 7-9
  - The problems grouped together
    - Must be dissimilar in process



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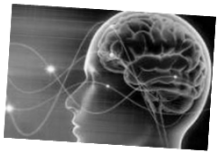
Summary of IPF

- 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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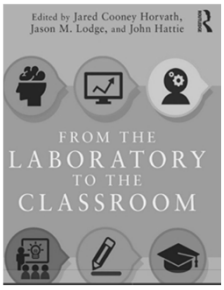
Where can I Learn More About IPF?

TEACHING Exceptional Children,
Special Issue on Purposeful Practice
2019 Volume 51, Issue 6

From the Laboratory to the Classroom: Translating Science of Learning for Teachers



Retrieval Practice

https://www.retrievalpractice.org/

@RetrieveLearn

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Meet the Presenter

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