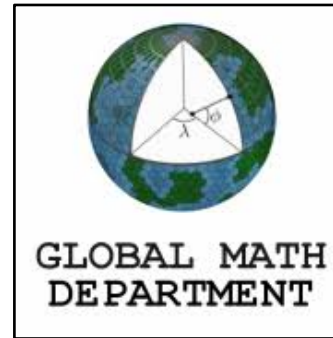


Promoting Mathematical Literacy: What Our Students Need to Know, Why They Struggle, and How We Can Help!



Mindy Adair, Ph.D.

Director of Mathematics – Denver Academy

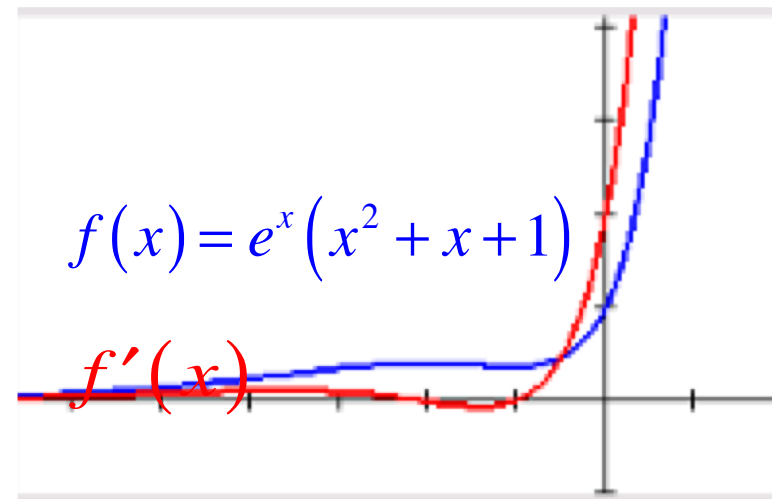
madair@denveracademy.org

[@AdairMindy](https://twitter.com/AdairMindy)

Promoting Mathematical Literacy: What our students need to know, why they struggle, and how we can help!

Agenda:

- Welcome and Warm Up
- Mathematical Literacy
 - A. What our students need to know
 - B. Why they struggle
 - C. How we can help
- Closing and Reflections



Presentation slides available at:
<https://www.mathsforallradair.org>

WARM UP:

REFLECT ON THIS
PICTURE...

What do you notice?
What do you wonder?
What do you think?



WARM UP:

HOW MANY?

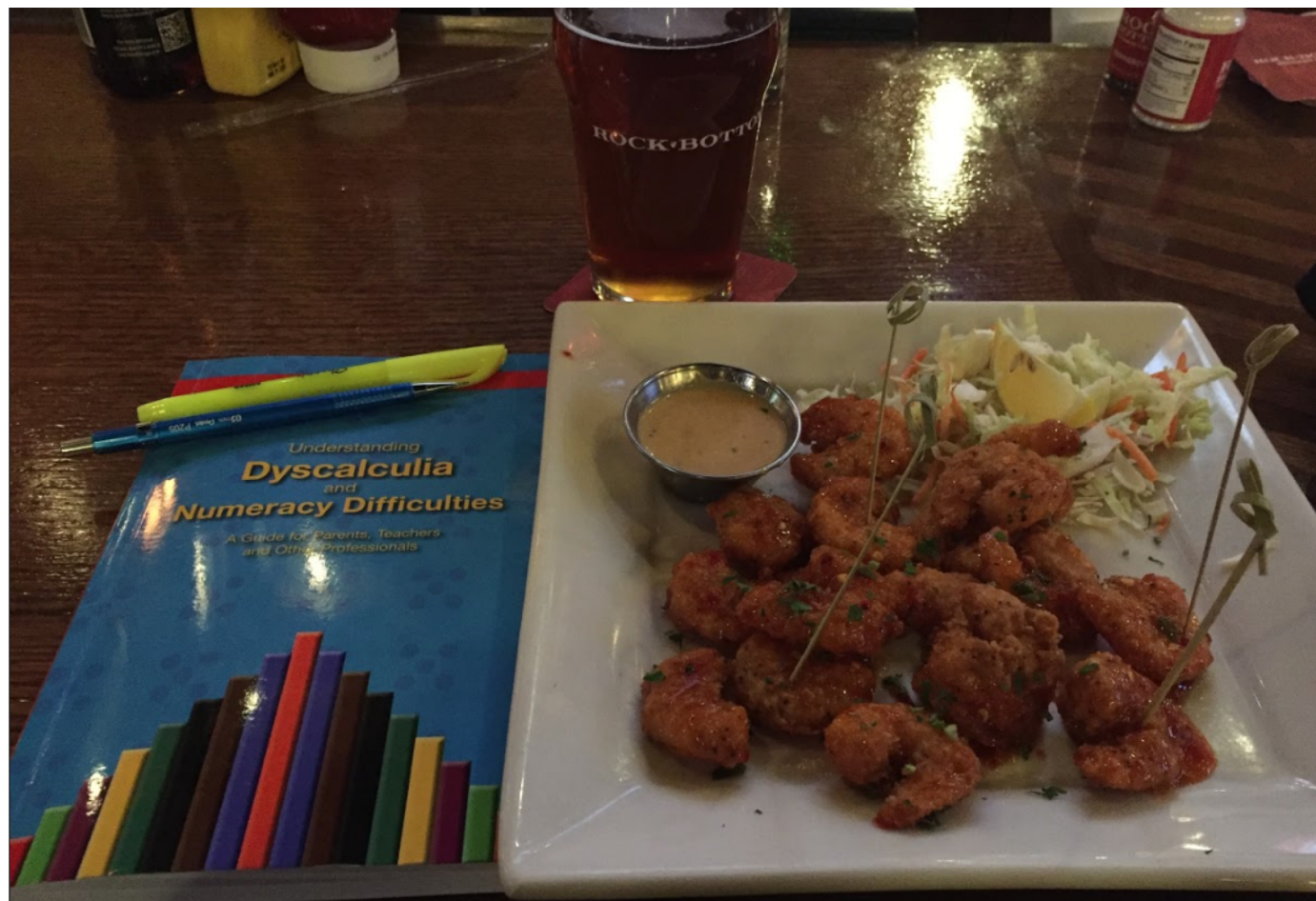
How Many?

Christopher Danielson



π

How Many?



REFLECTIONS:

IN THE CHAT, OR IN
YOUR JOURNAL...

1. How did each activity make you feel?
2. Are you relieved that these were our first tasks together?



Geometric Beasts by: Kerby Rosanes

REFLECTIONS:

WHAT IF I HAD ASKED:

Please prove the following trigonometric identity:

$$\tan x + \cot x = \sec x \cdot \csc x$$

Will this change our conversation? With our students?

Proof:

$$\tan x + \cot x = \sec x \cdot \csc x$$

$$\frac{\sin x}{\cos x} + \frac{\cos x}{\sin x} = \sec x \cdot \csc x$$

$$\left[\frac{\sin x}{\sin x} \right] \cdot \frac{\sin x}{\cos x} + \left[\frac{\cos x}{\cos x} \right] \cdot \frac{\cos x}{\sin x} = \sec x \cdot \csc x$$

$$\frac{\sin^2 x + \cos^2 x}{\sin x \cdot \cos x} = \sec x \cdot \csc x$$

$$\frac{1}{\sin x \cdot \cos x} = \sec x \cdot \csc x$$

$$\frac{1}{\sin x} \cdot \frac{1}{\cos x} = \sec x \cdot \csc x$$

$$\csc x \cdot \sec x = \sec x \cdot \csc x$$

$$\sec x \cdot \csc x = \sec x \cdot \csc x$$

QED

Three Goals for us today...

1. We will do Maths.
2. We will challenge our perspectives and messages regarding *who* can do maths.
3. You will leave here knowing how funny I am.

Cause I am – funny. Just sayin.

Our Biases, Our Insecurities:

The Cocktail Party...

“What do you do for a living?”



Our Biases, Our Insecurities:

The Airport Bar...

Lady at the end of bar:



“I am very good at math and I can do it in my head.”

Mathematical Literacy:

- “Mathematical Literacy provides learners with an awareness and understanding of the role that mathematics plays in the modern world.”
- “It enables learners to develop the ability and confidence to think numerically and spatially in order to interpret and critically analyze everyday situations and to solve problems.”
 - South Africa – Department of Education

Honoring our Differences...

- Mathematics is for all.
- Mathematics is developmental.
- It requires work, patience, and determination.
- What *we* say matters – it matters deeply.



Kerby Rosanes:
Geometric Beasts

A Task for our students - Visual Spatial

› Can you make a set of tally marks that follow some pattern?



Some Middle School Student Responses:

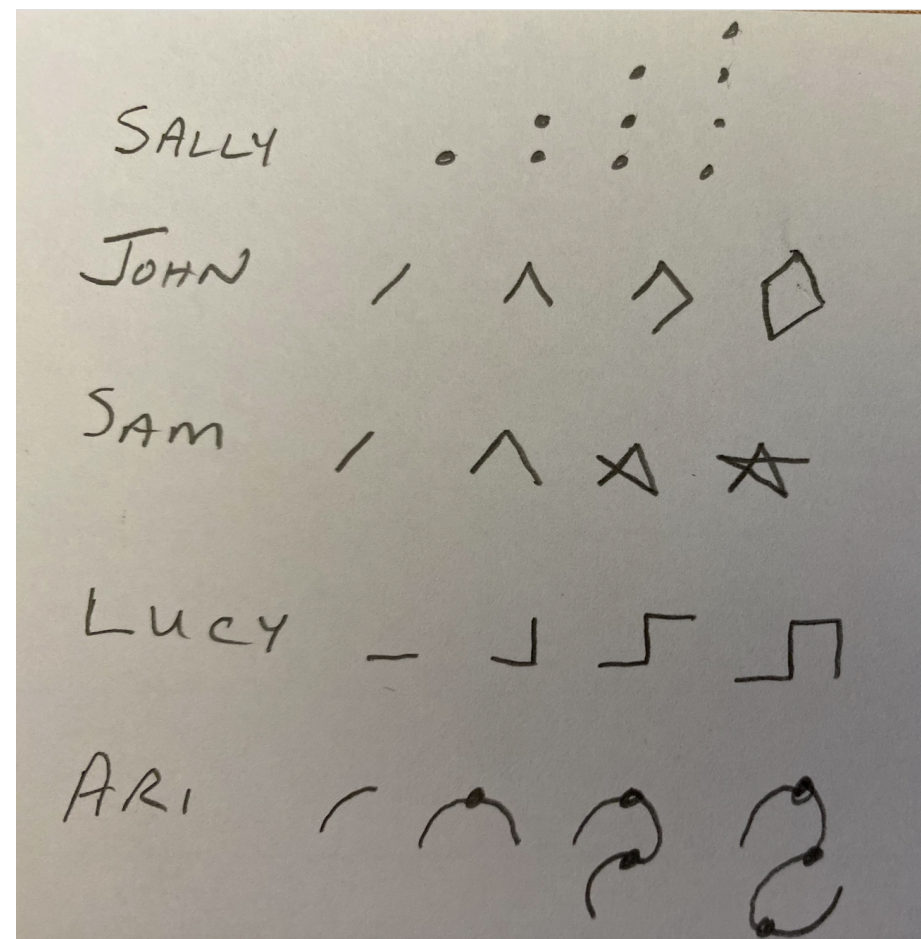
Explicit instructions for how students can share their thinking is critical:

Such as:

Pencil to paper.

Whiteboard to camera.

Thoughts in the chat.

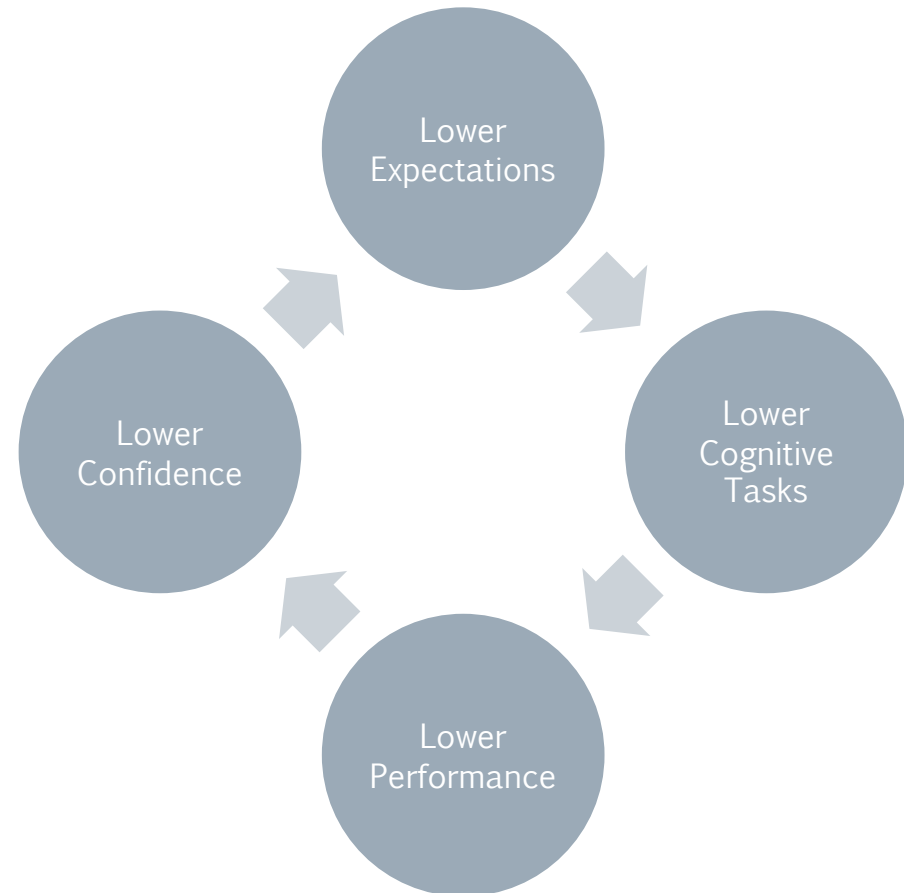


Some Initial Thoughts...

- › Valuing student thinking is paramount!
- › Mathematical content matters!
- › Integrity of the discipline is essential!
- › How we access it with our students is critical!

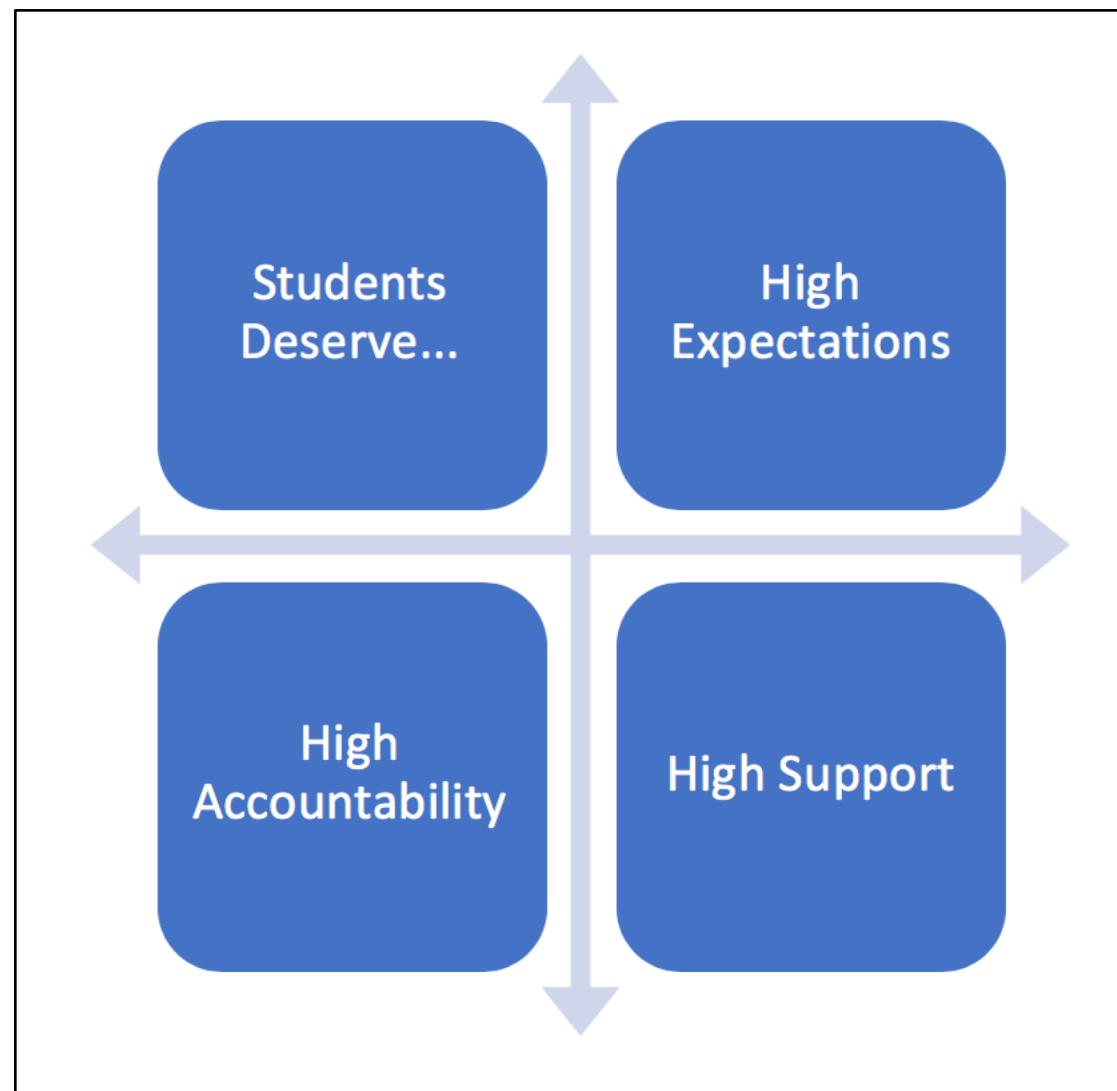
The Pygmalion Effect: Andrew Gael NCTM 2018

- › Our beliefs affect our actions towards others and their corresponding actions.



Denver Academy:

We work to honor all learners...and appreciate that learning in mathematics is a journey.



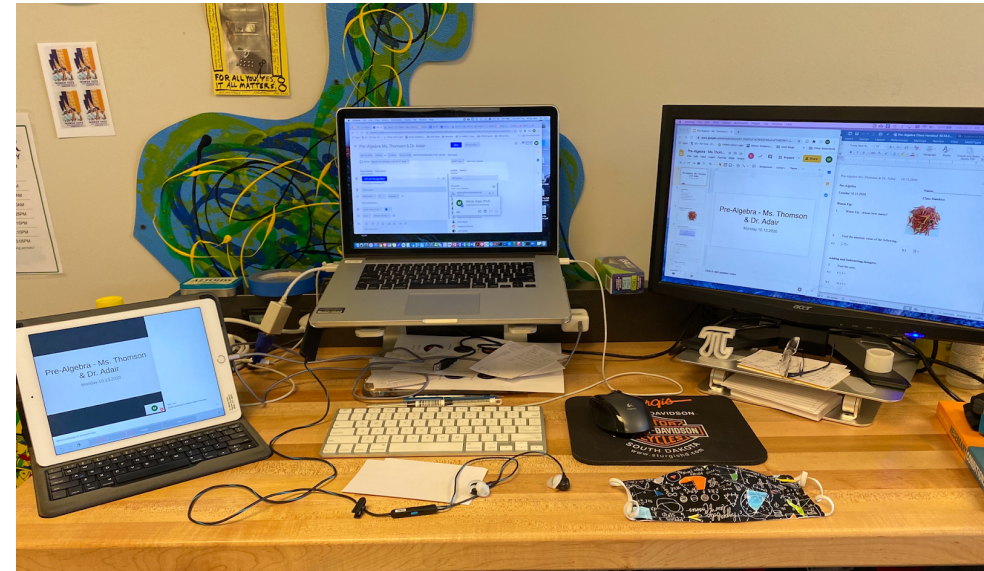
Our Big Five!

- › H – Hand Washing
- › A – Apart 6-Feet
- › N – Never without a mask
- › D – Diagnose at home
- › S – Safe Culture



π

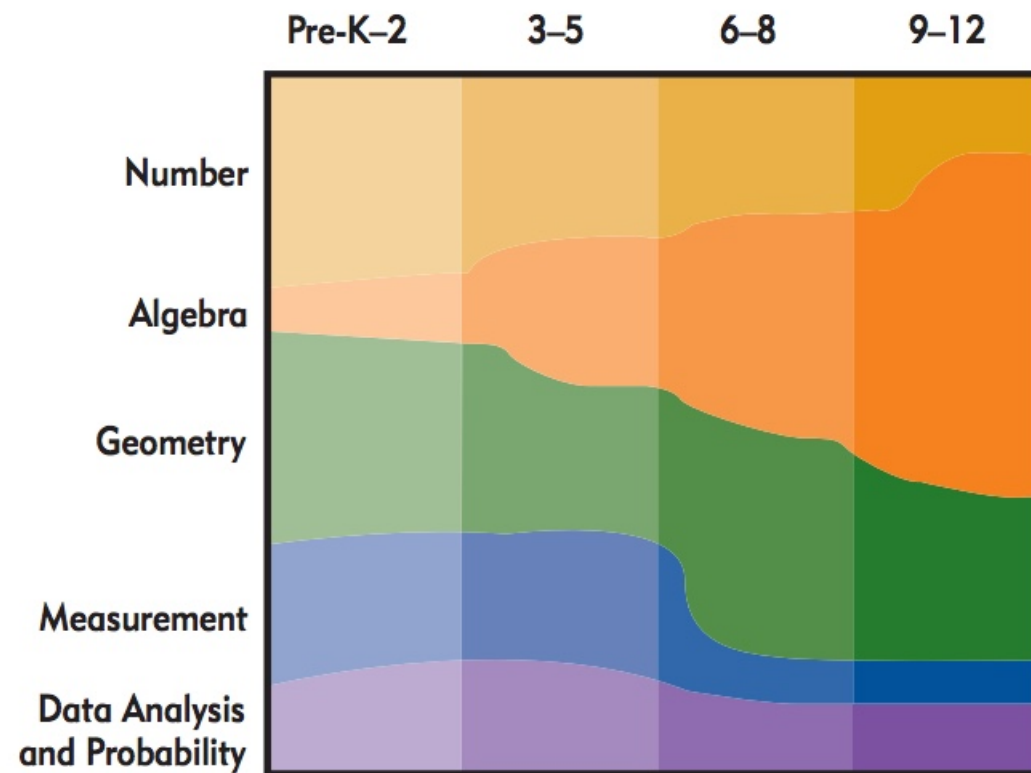
Managing this learning landscape is a challenge!



A. What do our students need to know?

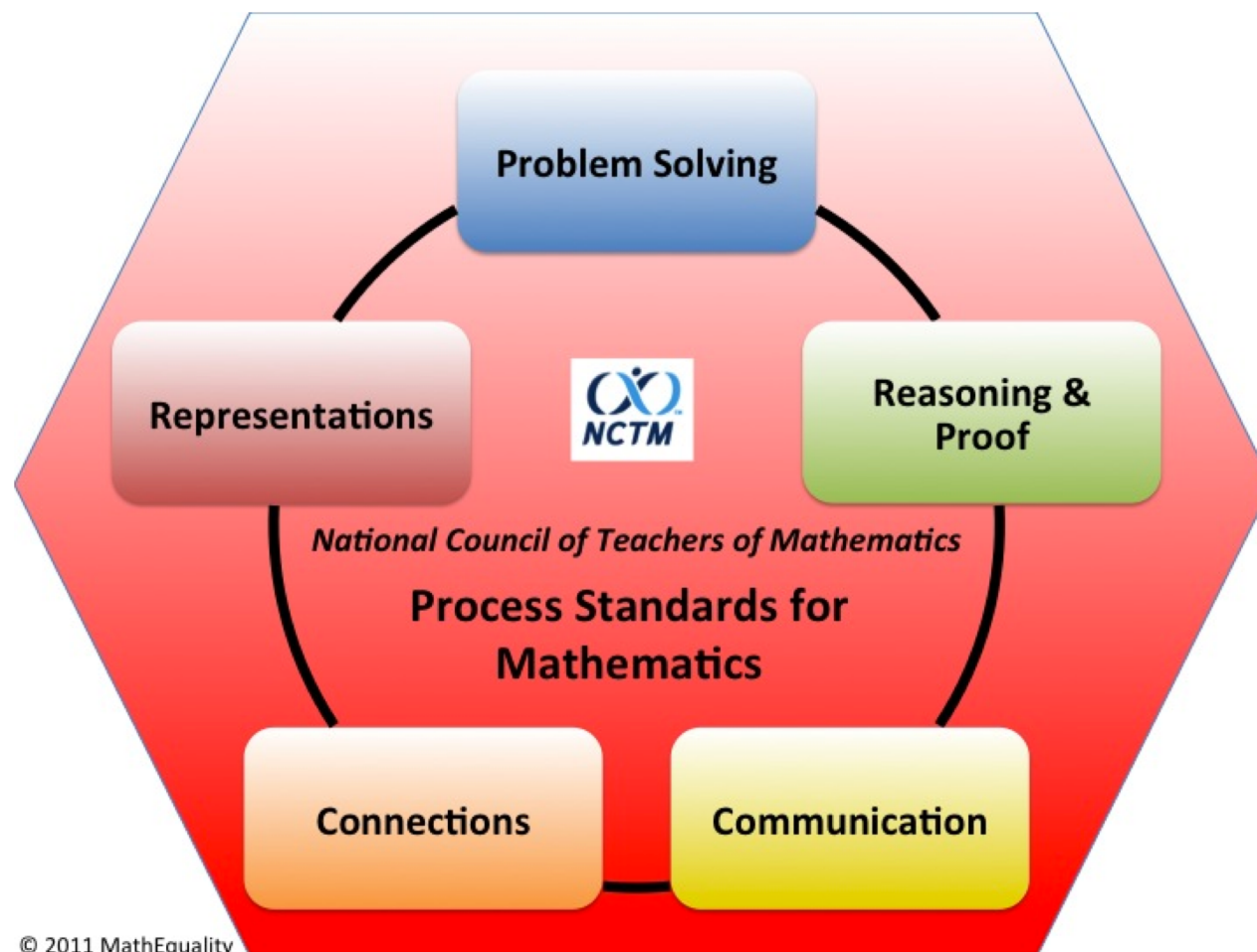
- Content Standards – NCTM – **What do our kids know?**
 - Numbers and Operations, Algebra, Geometry, Measurement, Data Analysis and Probability
- Processing Standards – NCTM – **What can our kids do?**
 - Problem Solving, Reasoning and Proof, Communication, Connections, Representations
- Quantitative Literacy – **How can our kids function?**
 - Being able to successfully navigate in the world mathematically

NCTM Content Standards



*The Content Standards
should receive different emphases
across the grade bands.*

NCTM Processing Standards



© 2011 MathEquality

Quantitative Literacy

- › Small Bottle – How many?
- › Big Bottle – How many?
- › What do you call the big bottle?



Does that number make sense?



- › Pam Adams, my wife, is amazing!
- › 20 “true” marathons...plus one!

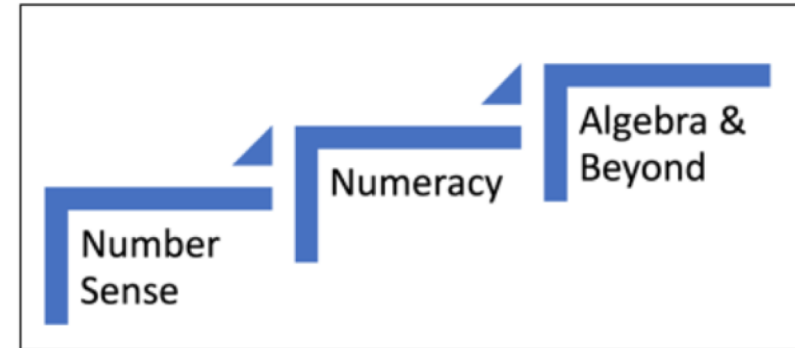


Boston
2018



New York
2018

Numeracy...



- › “The ability to make sense of numbers and to use them effectively in real life situations.”

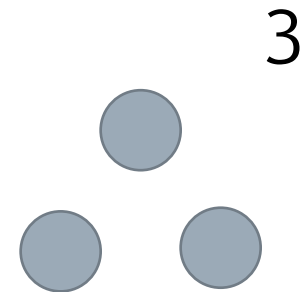
Understanding Dyscalculia and Numeracy Difficulties – Patricia Babbie & Jane Emerson, p. 35

- › As students continue to struggle, the temptation is “to concentrate even harder on a narrow range of activities.”

Mathematics for Dyslexics and Dyscalculics - A Teaching Handbook – Steve Chinn & Richard Ashcroft, p. 269

Early Numerical Development

- › Ability to assess numerical quantity is a profound challenge for students with dyscalculia.
- › Difficulty in linking the representation of numerical quantity to the symbols.



Early Numerical Development

› The “Distance Effect”

› Compare: 3 to 5

Compare: 2 to 8

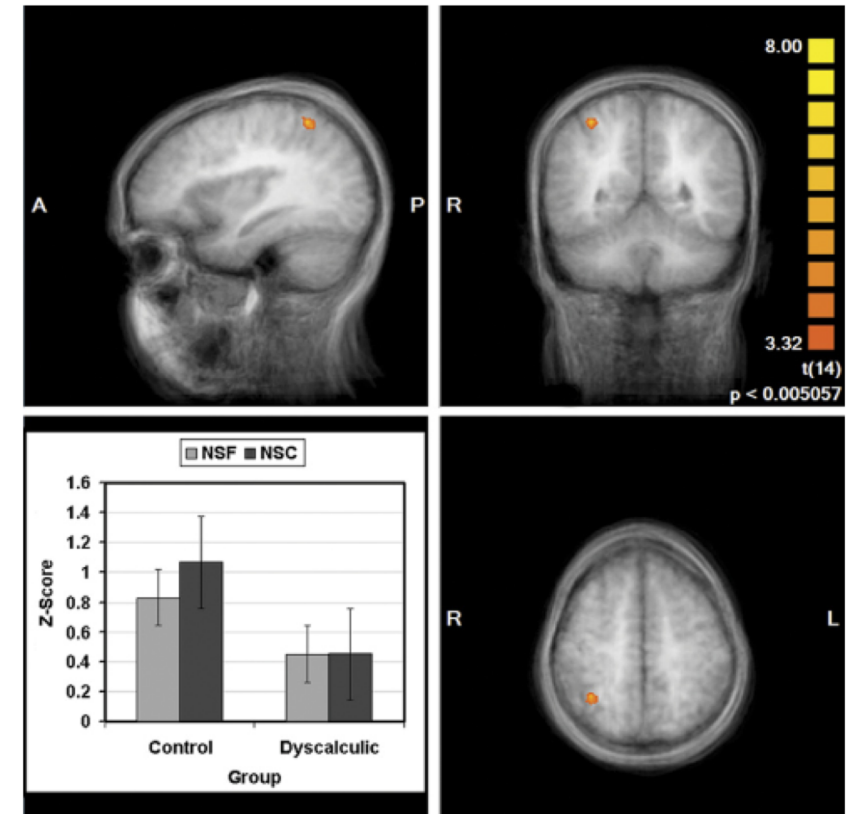
› “Numerosity comparison becomes increasingly difficult as the numerical distance between the comparators is decreased.”

Price, G. R., Holloway, I., Räsänen, P., Vesterinen, M., & Ansari, D. (2007). Impaired parietal magnitude processing in developmental dyscalculia. *Current Biology*, 17(24), R1042–R1043.
<https://doi.org/10.1016/j.cub.2007.10.013>

Research – The Distance Effect

“The the interaction in the brain was characterized by: a stronger distance effect in the control group than in the DD group

suggesting a lack of modulation of parietal numerical processing mechanisms in response to increasing numerical task demands in DD children.”



Price, G. R., Holloway, I., Räsänen, P., Vesterinen, M., & Ansari, D. (2007). Impaired parietal magnitude processing in developmental dyscalculia. *Current Biology*, 17(24), R1042–R1043. <https://doi.org/10.1016/j.cub.2007.10.013>

Additional Research...

› Two groups: Dyscalculia and non-Dyscalculia.

Congruent Pair: 3 5 Incongruent Pair: 5 3

Students were asked about the two numbers:

Congruent Pair: Physically larger – not big difference.

Incongruent Pair: Numerically larger – big difference

Price, G. R., Holloway, I., Räsänen, P., Vesterinen, M., & Ansari, D. (2007). Impaired parietal magnitude processing in developmental dyscalculia. *Current Biology*, 17(24), R1042-R1043.
<https://doi.org/10.1016/j.cub.2007.10.013>

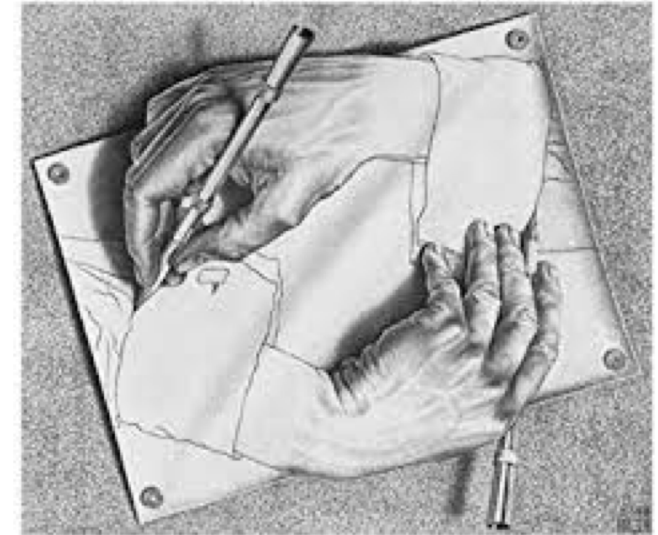
Supporting Numerical Development!

- › Create opportunities to engage with numbers!



We can all do Maths...

- Growth Mindset – Carol Dweck
- Mathematical Mindsets – Jo Boaler
- GRIT: The Power of Passion and Perseverance – Angela Duckworth
- Productive Struggle - NCTM



M.C. Escher

B. Why do our students struggle?

1. Mathematics as a Language and Discipline is Complex
2. Social and Emotional Considerations
3. Environmental Influences
4. Learning Profiles – Maths Learning Difficulties

1. Mathematics as a Language and Discipline

3.

▪ **Conceptual Understanding:**

- Understanding Why

1

▪ **Procedural Fluency:**

- Understanding How

4

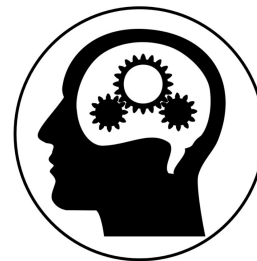
▪ **Automaticity & Developmental Progress:**

- Sophisticated and Precise Mathematics

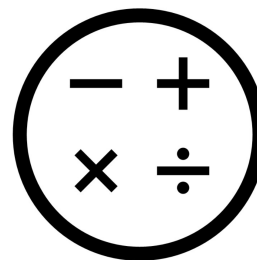
$$\pi \approx 3.141592653\dots$$

Three Aspects of Rigor

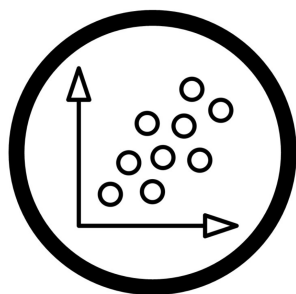
A. Conceptual Understanding



B. Procedural Skills and Fluency



C. Application



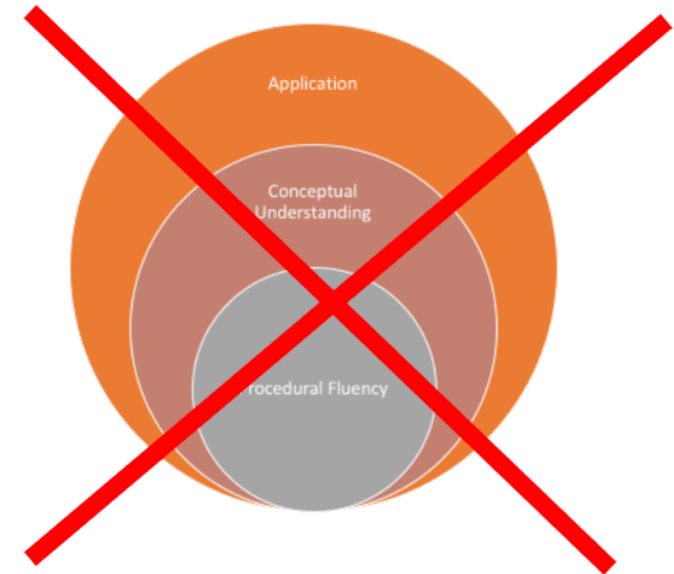
Logos designed by Veronica Fiedler

Rigor In Mathematics

“Rigor refers to deep, authentic command of mathematical concepts.” <http://www.corestandards.org/other-resources/key-shifts-in-mathematics/>

We are tempted to think...

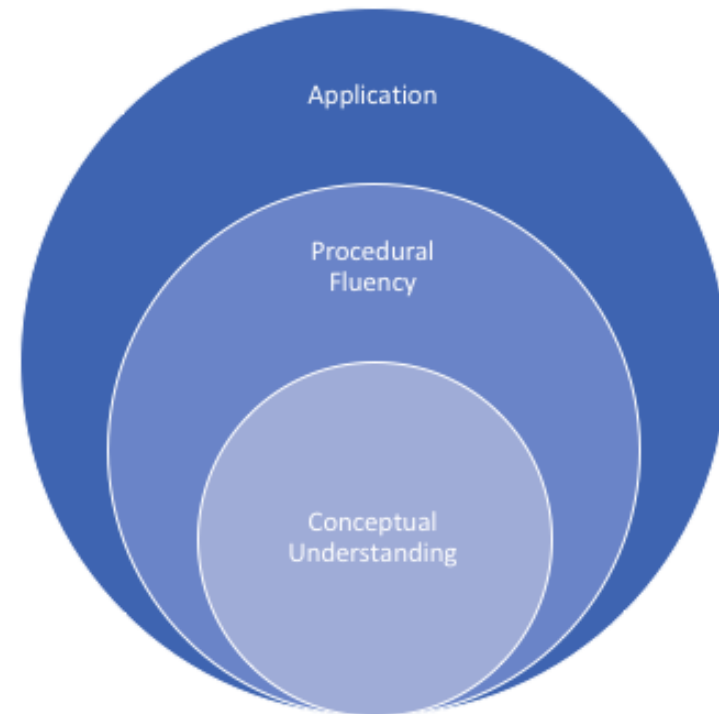
Procedural Fluency is at the core.



Rigor In Mathematics

“Rigor refers to deep, authentic command of mathematical concepts.” <http://www.corestandards.org/other-resources/key-shifts-in-mathematics/>

When really,
Conceptual Understanding
is the key!



Three Strategies that Promote Engagement

A. Conceptual Understanding:

Strategy #1: Create Necessary Conditions

B. Procedural Fluency:

Strategy #2: Be Intentional with Instructional Delivery

C. Application:

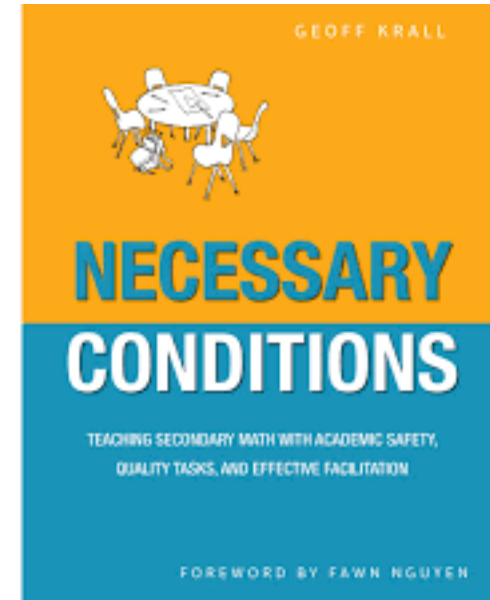
Strategy #3: Promote Strategic and Mathematical Thinking

A. Conceptual Understanding

Strategy #1:

Create Necessary Conditions

- Academic Safety
- Quality Tasks
- Effective Facilitations



Geoff Krall - Necessary Conditions

<https://www.stenhouse.com/content/necessary-conditions>

B. Procedural Fluency

Strategy #2:

Be Intentional with Instructional Delivery

- Explicit Instruction (Modeling, Practice, Support)
- Precise Language
- Multiple Representations

Sarah Powell, Ph.D. Associate Professor UT Austin

<http://www.sarahpowellphd.com/>

Global Math Department Presentation 10.6.2020



C. Application

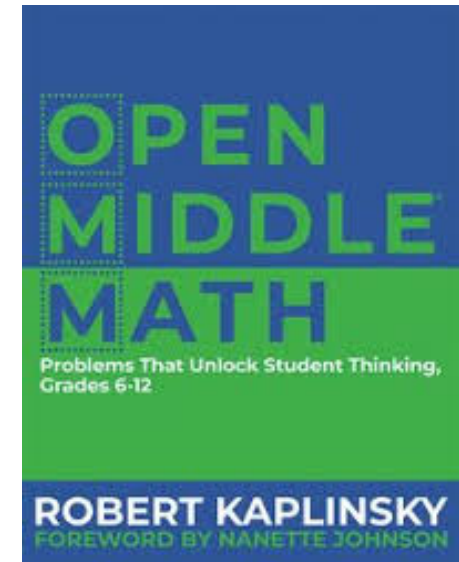
Strategy #3:

Promote Strategic and Mathematical Thinking

- Explain instructions and use interesting problems
- Allow students to work the problems
- Value the journey of thinking

Robert Kaplinsky - <https://robertkaplinsky.com/>

Open Middle Math



Open Middle Problems

RADICAL EQUATIONS

Directions: Using the digits 0-9 at most one time each, make both of these equations true.

$$\sqrt{\square\square\square} = \square \sqrt{\square}$$

$$\sqrt{\square\square\square} = \square$$

Open Middle Problems

RADICAL EQUATIONS

Directions: Using the digits 0-9 at most one time each, make both of these equations true.

$$\sqrt{\boxed{1}\boxed{8}} = \boxed{3} \sqrt{\boxed{2}}$$

$$\sqrt{\boxed{4}\boxed{9}} = \boxed{7}$$

2. Social and Emotional Considerations

3.

- **Mindset – Growth or Fixed:**

- I can, I will, I want to...

1

- **Confidence, Insecurities, Anxiety:**

- Yet, not yet.

4

- **Motivation, Interest, Work Attitude:**

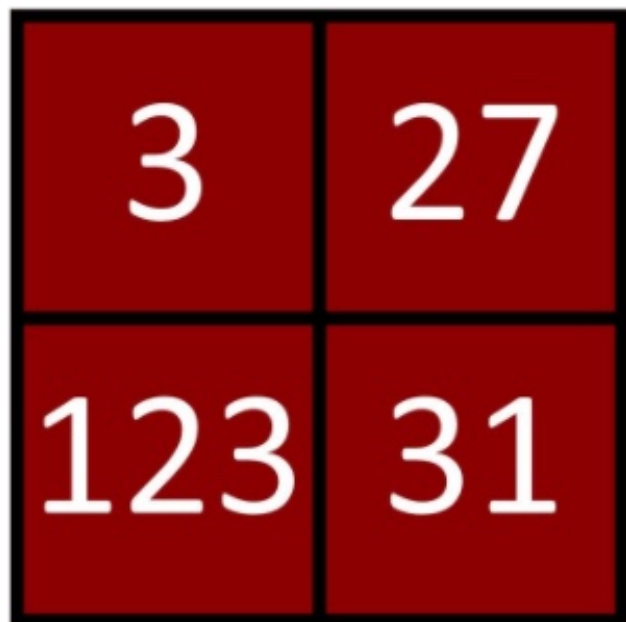
- Character Building

Mathematical Tasks...Low Floor High Ceiling

- › Which One Doesn't Belong – Mary Bourassa
- › Youcubed – Jo Boaler
- › Visual Patterns – Fawn Nguyen
- › Estimation 180 – Andrew Stadel

Doing Mathematics is Empowering!

Which One Doesn't Belong:

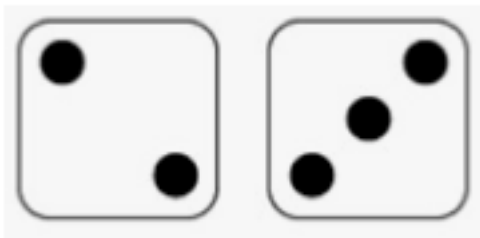


Mary Bourassa <http://wodb.ca/>
and Christopher Danielson

“Do math and you can do anything!” - NCTM

Let's Bowl! Rolling Number Cubes...

› Roll #1:



› Roll #2:



Maths Tasks 2019 Mindy Adair, Ph.D. 1

Bowling: Roll two dice. Those are your seed numbers. Use any mathematical operation to get the numbers 1 – 10 using only those two numbers. When (if) you get stuck – you get a second roll.

Scoring. After you have exhausted the second roll options – **count up the number left** (total of the pins) **and that is your score for that frame. Low score wins.**

Name: _____

1	2	3	4	5	6	7	8	9	10	Total
6	2									
2										

Roll #1
3, 2

Roll #2
4, 2

<p>Frame 1 equations</p> $3 + 2 = 5$ $2^3 = 8$ $3 - 2 = 1$ $3 * 2 = 6$ $3^2 = 9$ $\sqrt{3^2} = \sqrt{9} = 3$	$4 - 2 = 2$ $\sqrt{4} * 2 = 2 * 2 = 4$ 2 LEFT	
<p>Frame 2 equations</p>		

Presented by Dr. Barbara Dougherty at Math on the “Planes” - Denver, CO 2.23.18

Four Fours!

Four Fours:

Make all the numbers from 1 to 20 using exactly four fours and any mathematical operation. You must use four fours. To extend the problem – expand to the numbers from 1 to 100. Students can expand to 100.

Taken from: Jo Boaler [Mathematical Mindsets](#) page 80.

Four 4's Problem			
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20



Mathematical Anxiety...

- › Unnecessary Pressure
- › Timed Expectations
- › Public Situations
- › Lack of Confidence



Our messages to students...in the chat...

Name:

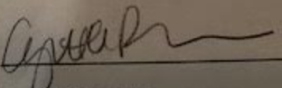
Mad Minute Results for September 14-17

	Addition	Subtraction	Multiplication	Division
Letter Grade		F	F	D-
Number Correct		26	26	30

Grading Scale

Your child is timed for 2 minute 30 seconds this trimester.

A 45 - 50
B 40 - 44
C 35 - 39
D 30 - 34
F 0 - 29


Parent Signature

What does this message send to the student?

Does the message change for various students?

How does their identity, race, gender, impact the message?

Recent Research...

- › Dr. Jo Boaler & Tanya LaMar – Stanford
- › “Valuing Difference and Growth: A Youcubed Perspective on Special Education” – 2019
 - Difference in Maths Learning
 - Maths Anxiety Affects Achievement

- › Dr. Sian L. Beilock – President at Barnard College
- › “Math Performance in Stressful Situations” – 2008
 - Situation Induced Pressure
 - Depleted Cognitive Resources

3. Environmental Influences

3.

- **Parents and Teachers:**
 - Attitudes and Content Knowledge

1

- **Curriculum - Coherent Scope and Sequence:**
 - Precise, Sophisticated, & Accurate Language; Pace

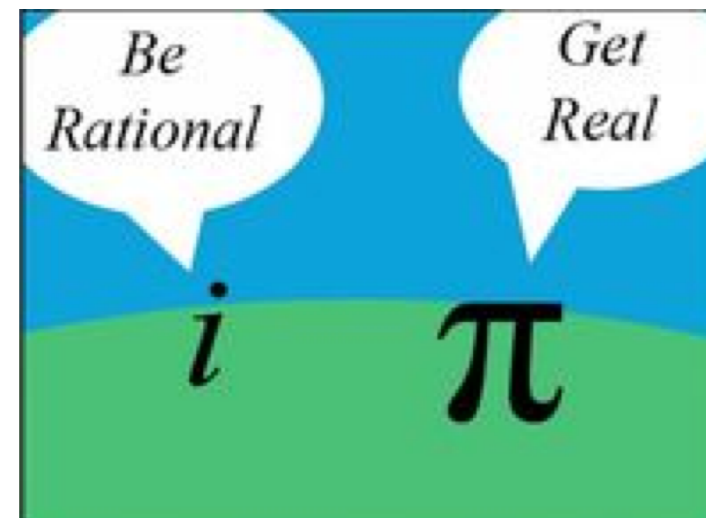
4

- **Resources – Materials and Technology:**
 - “Easy to Use and Useful!” – Fred Davis - 1989

What we say matters...deeply!

› In the chat: What do you say to your students/kids regarding mathematics that is:

- Discouraging...
- Encouraging...



Promoting Curiosity and Mathematical Thinking!

PLEASE DON'T SAY...

- › It is easy, let me show you.
- › I am just not a math person.
- › You are so smart!

HOW ABOUT...

- › What do you notice, wonder, think?
- › Help me understand your thinking.
- › I am proud of your effort.

Resources and Support...

- › Back in the Day (you know, last year!)
- › NCTM 2018 – DC



DC Metro



Metro is accessible.



Motivate

Plan

Execute



Review

Modify

Have a Drink

Adapt

Additional
Support



DC Metro

π

TO THE MALL

STATION → MT. VERNON
7th

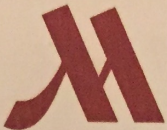
YELLOW TO HUNTINGTON
GREEN TO BRANCIF

OFF AT L'ENFANT PLAZA

TRANSFER

BLUE TO FRANCONIA
ORANGE TO VIENNA
SILVER TO WIEITLE

OFF AT SMITHSONIAN


MARRIOTT

BACK TO HOTEL

STATION → SMITHSONIAN

BLUE TO LARGO TOWN
SILVER TO LARGO TOWN
ORANGE TO NEW CARROLTON

OFF AT L'ENFANT PLAZA

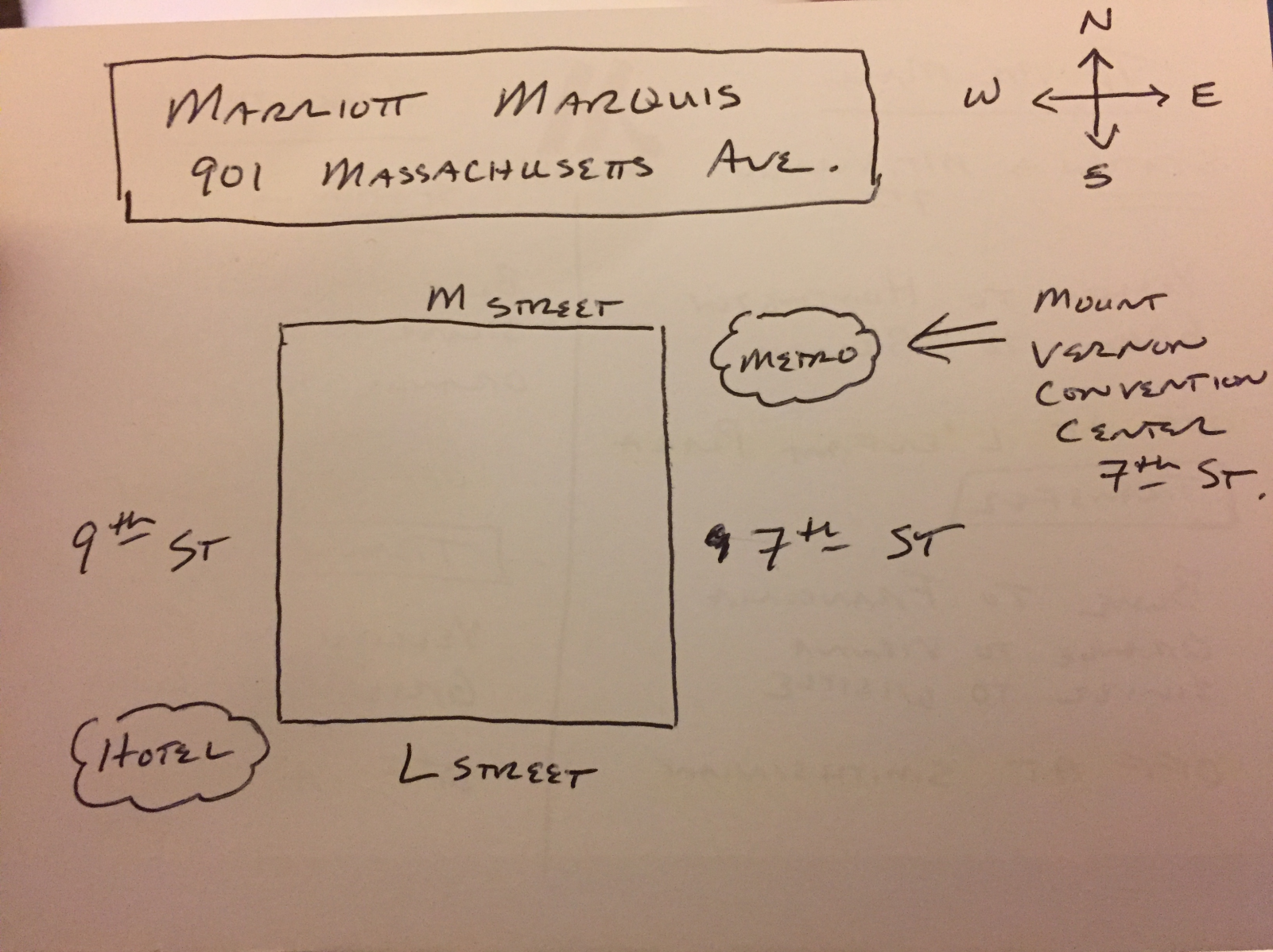
TRANSFER

YELLOW TO FORT TOTTEN
GREEN TO GREENBELT

OFF AT MT. VERNON
7th

DC Metro

π



Take Away: Provide Support & Resources!

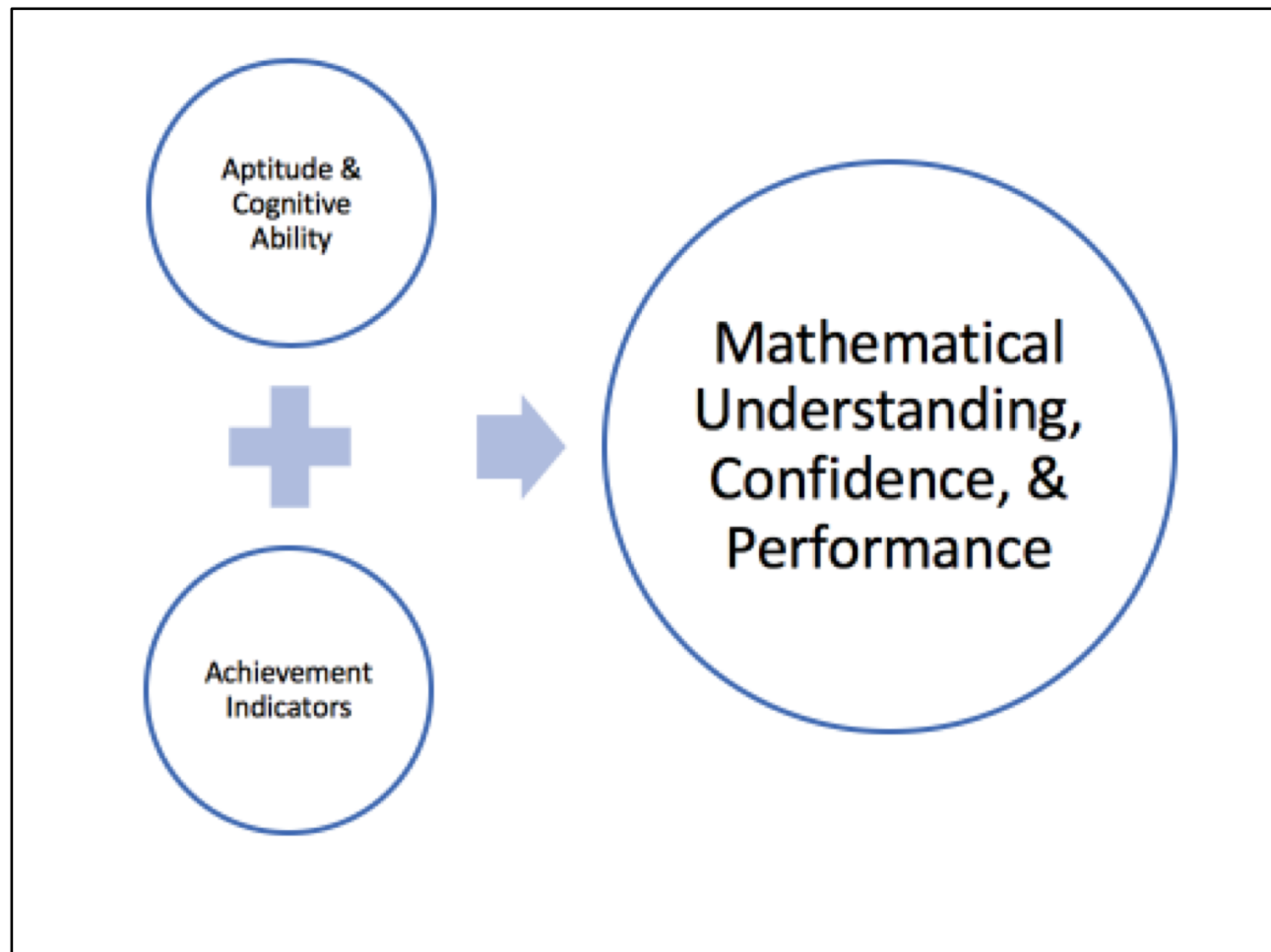
- › Fred Davis – 1989:
Technology Acceptance
Model:
- › “Easy to Use & Useful”



B. Review - Why do our students struggle?

1. Mathematics as a Language and Discipline is Complex
2. Social and Emotional Considerations
3. Environmental Influences
4. **Learning Profiles - Maths Learning Difficulties**

What is the nature of the struggle?



Struggles with Maths...Collect Data.

ACHIEVEMENT TESTS

Measure of what one has learned.

- › ACT
- › **IOWA Test of Basic Skills**
- › SAT II (subject mastery)
- › ISEE (Independent School Entrance Exam)
- › WIAT – III (The Wechsler Individual Achievement Test)
- › KTEA – III (Kaufman Test of Educational Achievement)

APTITUDE-COGNITIVE ABILITY

Attempts to predict one's ability to learn new skills and/or cognitive ability.

- › SAT (Scholastic Aptitude Test)
- › PSAT (Preliminary Scholastic Aptitude Test)
- › **WISC-V (Wechsler Intelligence Scale)**
- › Woodcock-Johnson Tests of Cognitive Ability
- › Stanford-Binet Test of Cognitive Ability

4. Maths Learning Difficulties

3.

- **Dyscalculia:**

- Difficulty with Number Concepts and Facts

1

- **Dysgraphia:**

- Difficulty with Written Language, Handwriting

4

- **Dyspraxia:**

- Difficulty with Fine and Gross Motor Skills

What is Dyscalculia?

The definition below comes from the American Psychiatric Association (2013):

*“Developmental Dyscalculia (DD) is a specific learning disorder that is characterized by **impairments in learning basic arithmetic facts, processing numerical magnitude and performing accurate and fluent calculations.**”*

These difficulties must be quantifiably below what is expected for an individual's chronological age, and must not be caused by poor educational or daily activities or by intellectual impairments.”

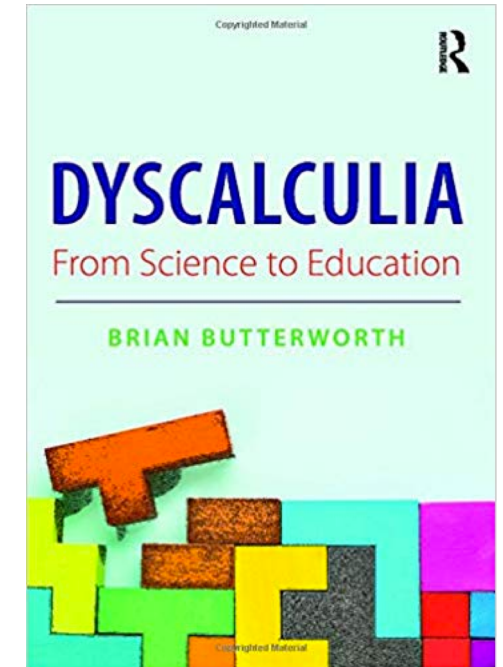
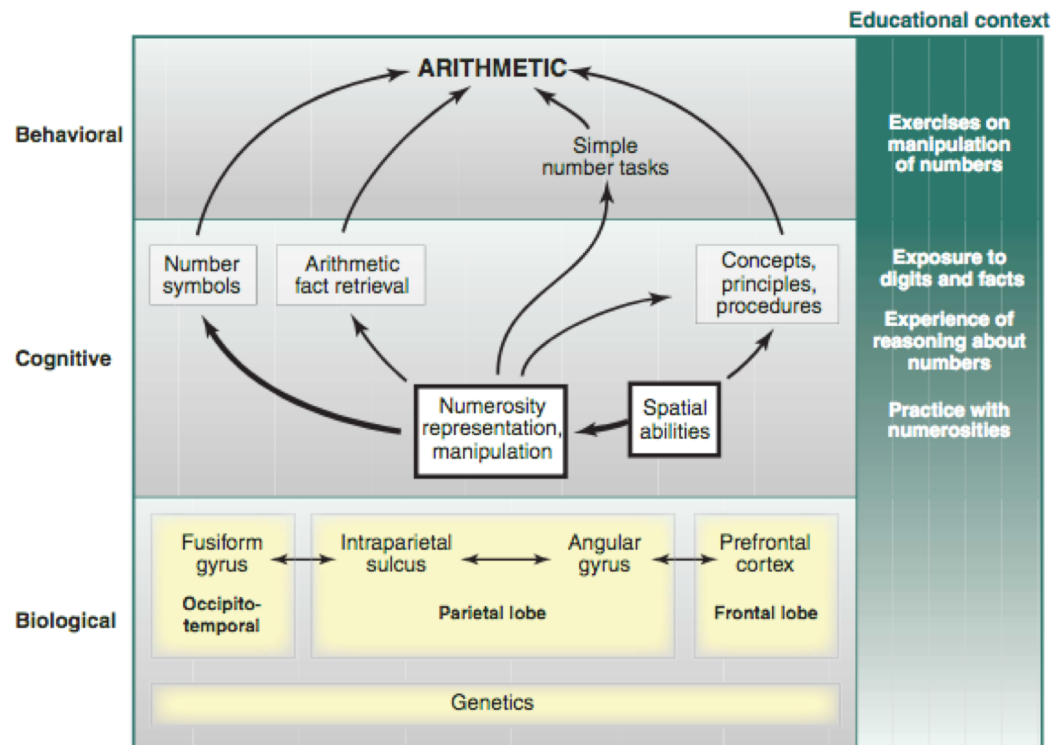
Maths Learning Difficulties - Dyscalculia

- Difficulty with number concepts and facts.

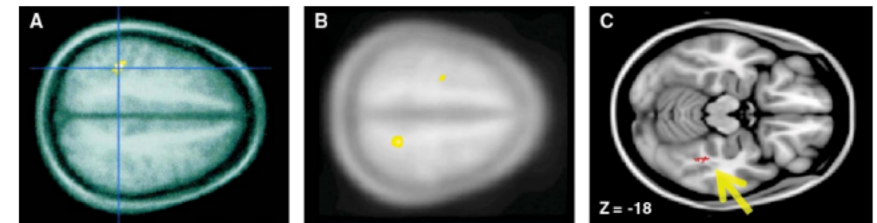
Dyscalculia	Indicators	Support
Unique Presentations for students	Trouble recognizing numbers and symbols	Avoid “Learned Helplessness” and passive learning
Visual Spatial Component	Lack of Fluidity with numbers (number sense)	Attend to memory and attention - review
Language of Math	Trouble with counting, estimating, patterns, rules, measurements	Metacognition – reflect on thinking & learning. Direct Instruction.

Dyscalculia and the Brain

- › Arithmetic Skills Affected
- › Brain region responsible – Left Parietal Lobe
- › Differences in Numerical Processing



Butterworth, 2019



Dyscalculia: From Brain to Education, Brian Butterworth, 2011

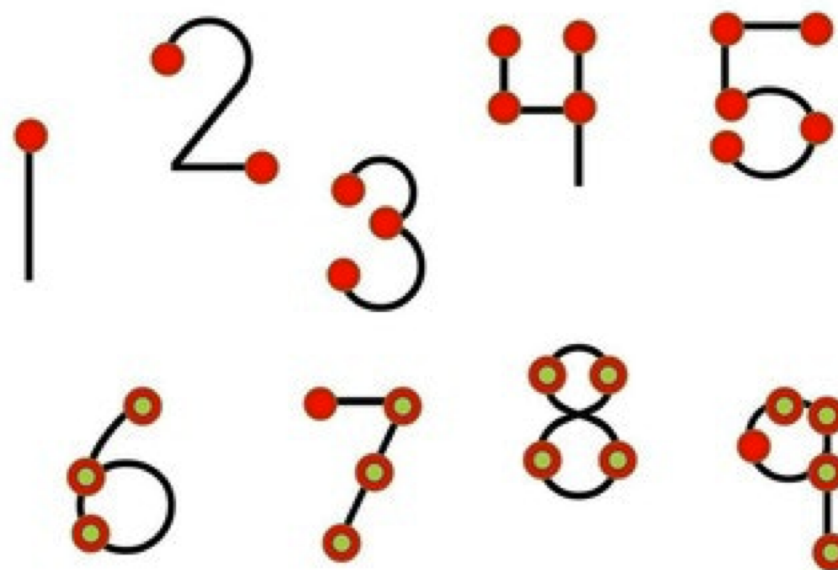
Maths Learning Difficulties - Dyscalculia

- Difficulty with number concepts and facts.

Use of Fingers



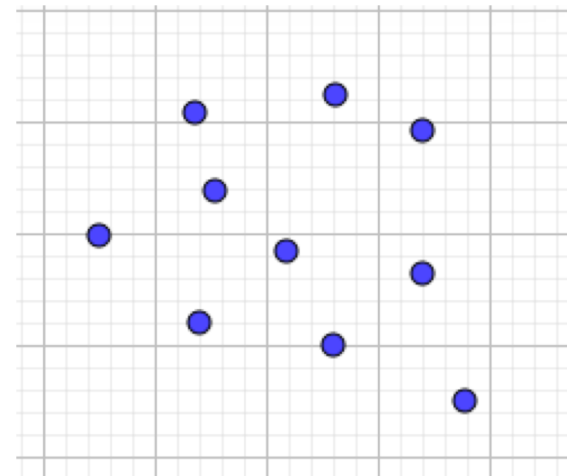
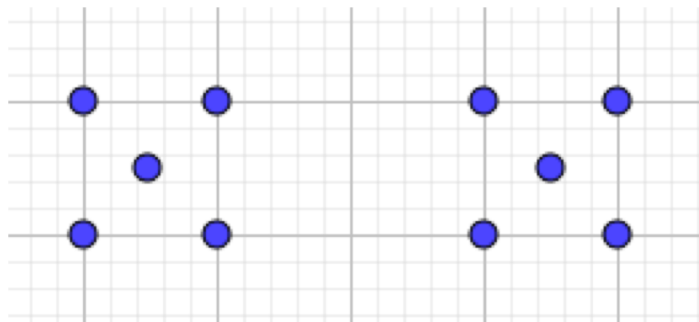
Touch Points (Math)



Maths Learning Difficulties - Dyscalculia

- Developing a conceptual understanding of a number.
- Creating a structured approach that supports learning.

“Using consistent and recognizable patterns for objects enhances the ability to recognize quantity, for example ten.” – Chinn, 2017

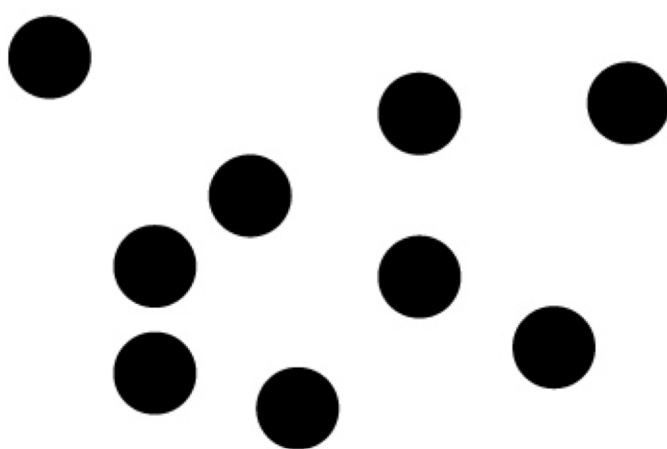


Maths Learning Difficulties - Dyscalculia

- Difficulty with number concepts and facts.
 - › Subitizing “is the ability to ‘see’ a small amount of objects and know how many there are without counting.”

HOW FAST CAN YOU COUNT THESE DOTS?

Children with dyscalculia take longer than other children to count dot patterns. Most instantly recognize patterns of up to four dots, whereas dyscalculics tend to count the dots one by one.

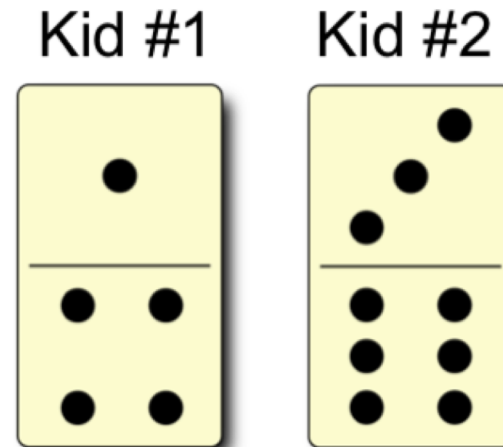


Maths Learning Difficulties - Dyscalculia

- Difficulty with number concepts and facts.

Low Floor High Ceiling Tasks – Dominos games:

- › Sorting by order
- › Addition – Subtraction
- › Multiplication
- › Fractions



Math Facts...and Automaticity...

- › Matter, but we should not insert a road block to learning because of them - Just saying!
- › Should be reviewed.
- › Assistive Technology...



Maths Learning Difficulties - Dysgraphia

- Difficulty with written language, handwriting.

Dysgraphia	Indicators	Support
This can impact the written language	Trouble organizing thoughts and putting them into writing	Access to class notes
It can affect both information and motor processing	Unreadable handwriting, slow and labored writing	Oral assessments
This can impact handwriting	Odd spacing of words and letters, poor punctuation skills	Extended time, typing assignments

Maths Learning Difficulties - Dyspraxia

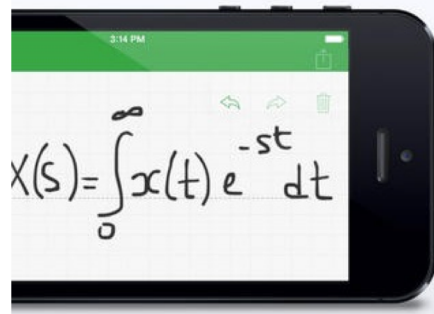
- Difficulty with fine and gross motor skills.

Dyspraxia	Indicators	Support
Can affect a person's conception of how his/her body moves in space	Trouble grasping a pencil	Speech to text technology
Can have physical awkwardness	Slow and messy handwriting	Practice and Repetition
May avoid situations (games/athletics) that draw attention	Trouble throwing a ball, using buttons	Larger print, more space, keyboarding

Maths Learning Difficulties – Dyspraxia and Dysgraphia

› Support

- Occupational therapy to help with balance and coordination
- Perceptual motor training – hear, see, move
- Assistive technology **** Should never do the math!**
 - An app that lets you dictate reminders rather than type
 - MyScript math app



Mind the Gap...



- › How can we help students who struggle with Maths?

- › We must decide what we think the issues are...

- › Collect Data!
 - Observations
 - Student Reflections
 - Educational Evaluations

Gaining Access to Student Thinking...

› Jamboard during Google Meet

The screenshot shows a Google Meet interface with a Jamboard overlay. On the left, a menu lists various meeting controls: Whiteboard (Open a Jam), Record meeting, Change layout, Full screen, Turn on background blur, Turn on captions, Settings, Use a phone for audio, Report a problem, Report abuse, and Help. The main whiteboard area features the name 'Hayden' with a profile picture, the instruction 'Please label the points with their integer values.', and a number line. The number line has tick marks from -6 to 6. Points P and Q are marked on the line. Handwritten labels below the line are: -6, -2, -3, 0, 4, 7, 6. A yellow sticky note on the right says 'fall and I don't know why'.

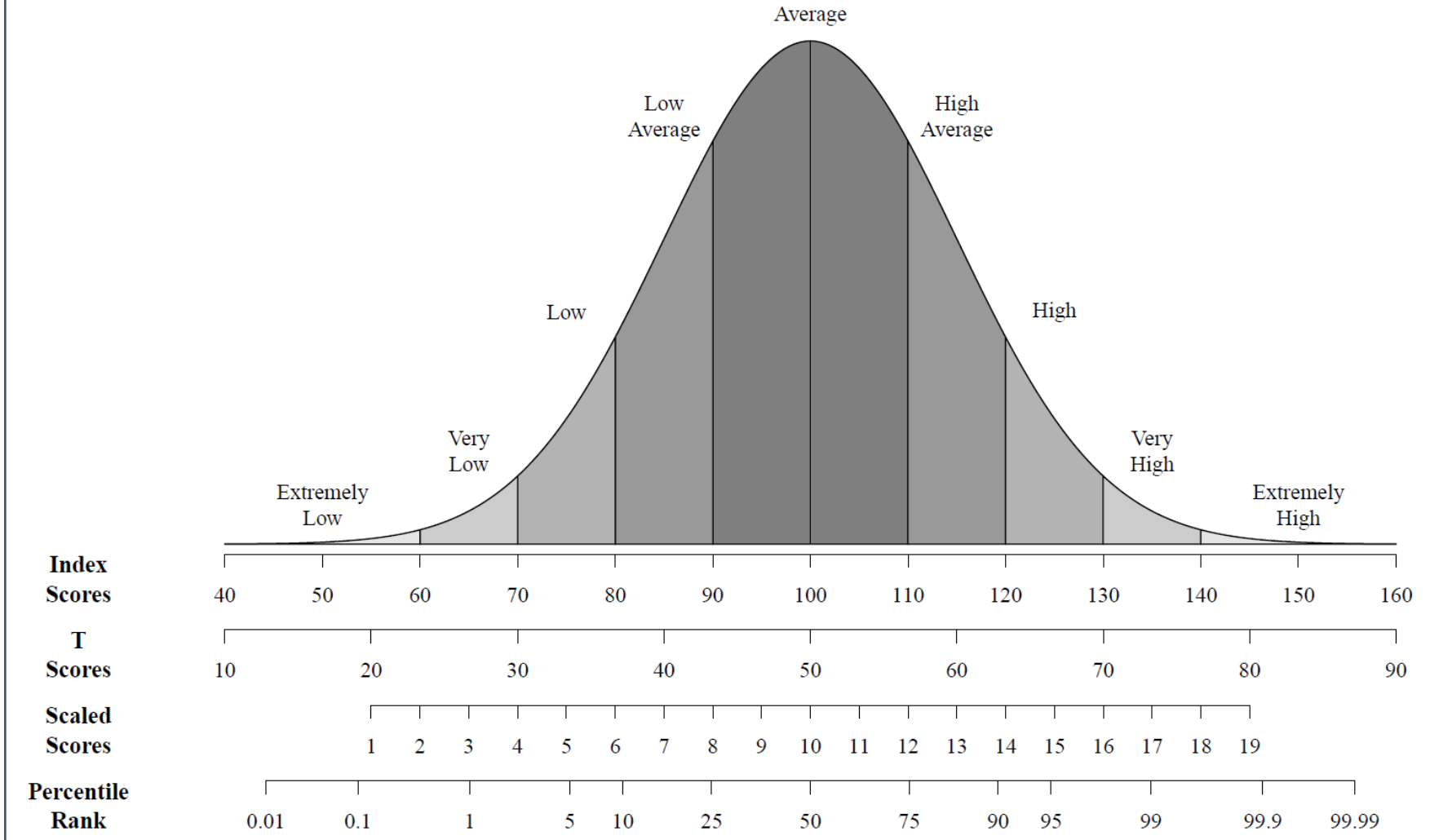
WISC-V: Wechsler Intelligence Scale for Children

Full Scale				
Verbal Comprehension	Visual Spatial	Fluid Reasoning	Working Memory	Processing Speed
Similarities	Block Design	Matrix Reasoning	Digit Span	Coding
Vocabulary	Visual Puzzles	Figure Weights	Picture Span	Symbol Search
Information		Picture Concepts	Letter-Number Sequencing	Cancellation
Comprehension		Arithmetic		

Image taken from [Intelligent Testing with the WISC-V](#), Kaufman, p. 3

**Sample Test Items taken from: Preparation Workbook for the WISC-V Test (2015)

Standard Scores



Maths Challenges...Learning Profiles

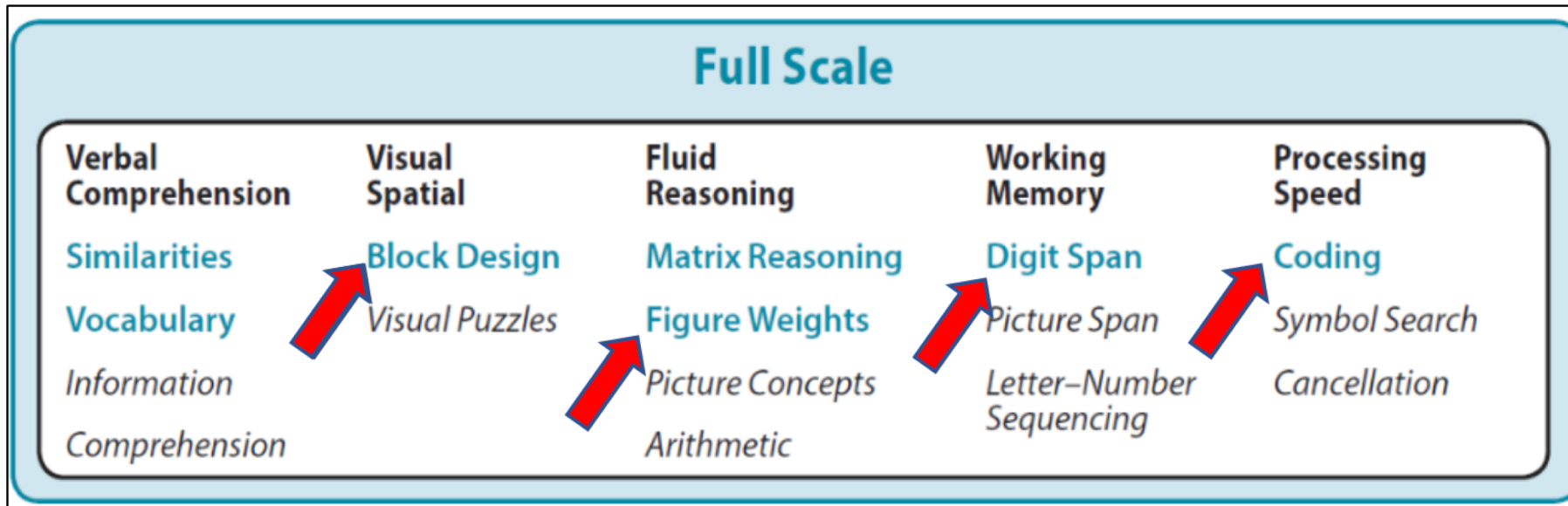


Figure taken from: (Alan S. Kaufman, 2016, p. 3)

Special thanks to my colleagues at Denver Academy: Cynthia Richardson & Philippe Ernewein – who are extraordinarily knowledgeable in this arena.

Visual Spatial Index (VSI)

Definition:

“The ability to perceive patterns and solve problems in the mind’s eye by manipulating visual imagery.” (Flanagan, 2017, p. 37)

Subtest:

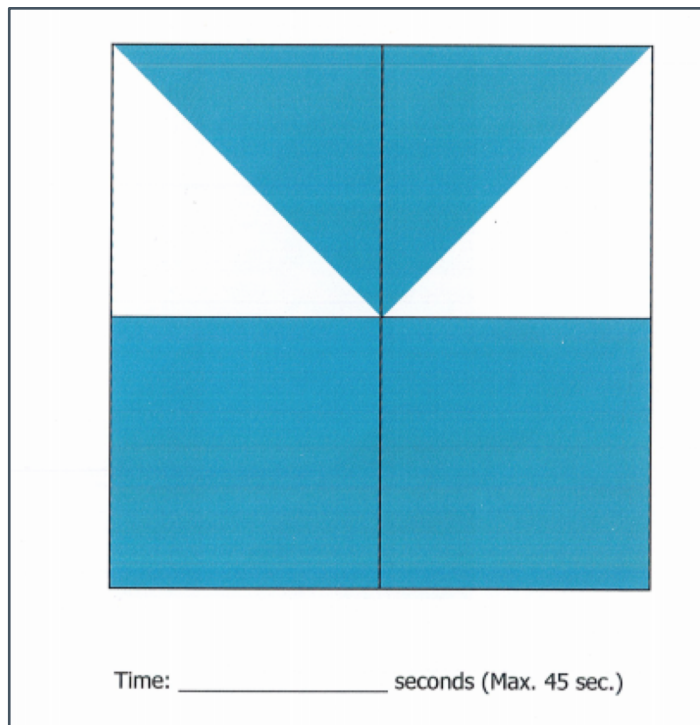
Block Design

Impact on Mathematics:

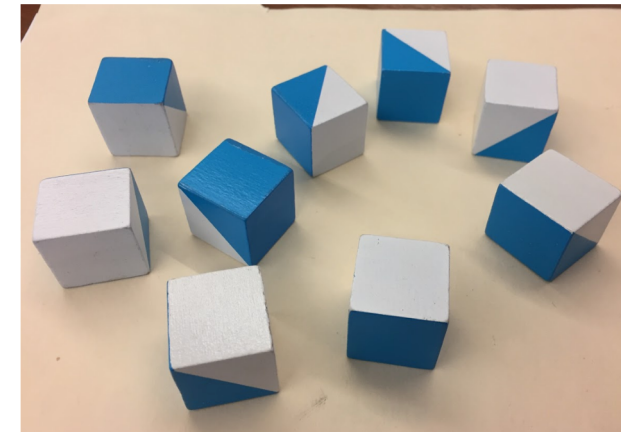
*Problem Solving and Mathematical Thinking;
Decision Making with Multiple Steps

Block Design

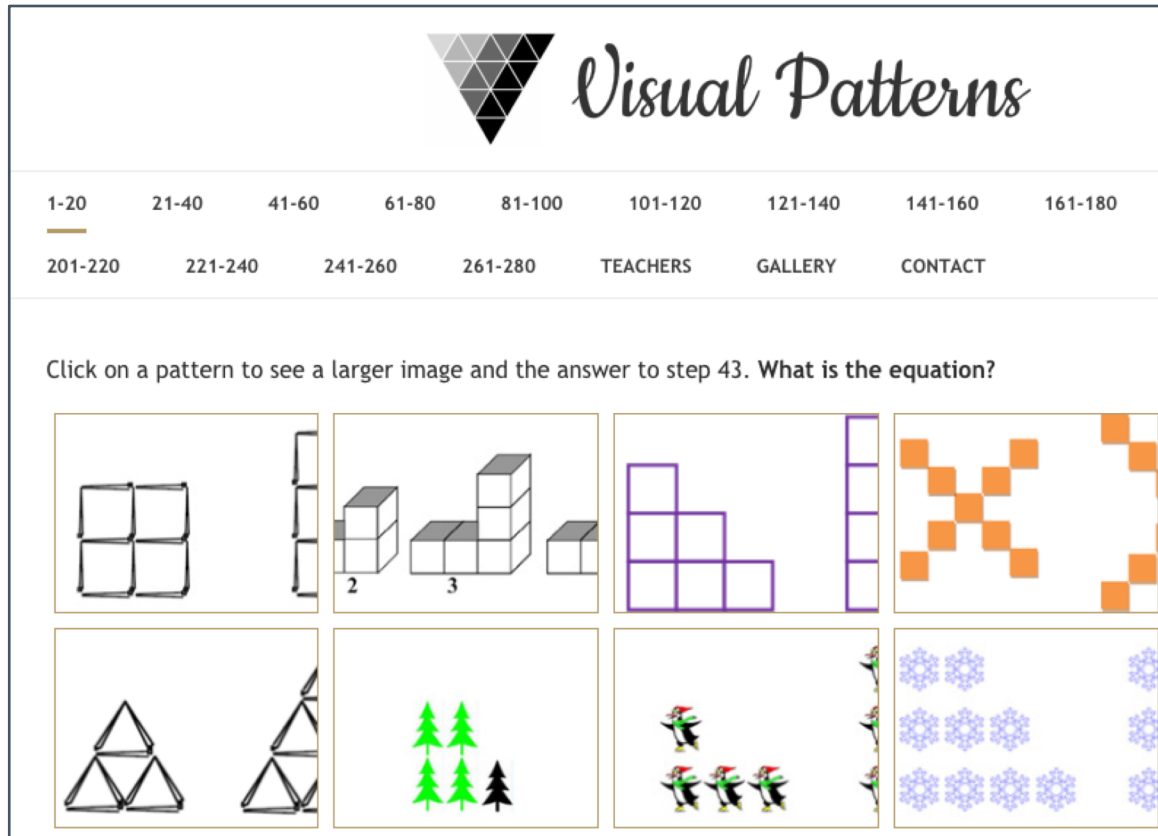
- › Shown 2-D image,
- › Build 3-D model in specific time.



Sample test items taken from:
Preparation Workbook for the WISC-V Test (Publishing, 2015)

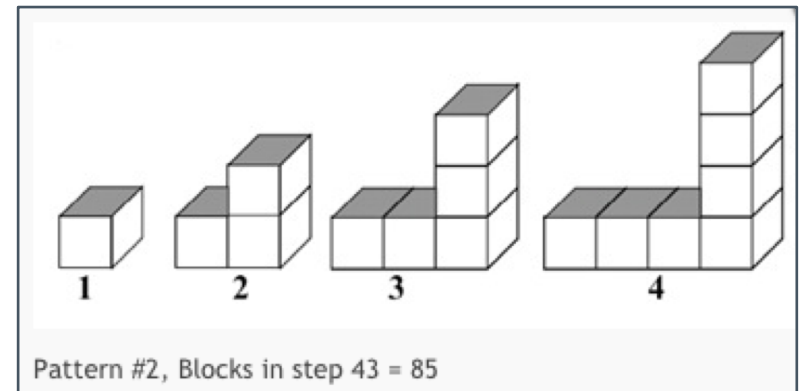


Support: Visual Patterns – Fawn Nguyen



The screenshot shows the homepage of the Visual Patterns website. At the top, there is a logo consisting of a triangle of grey and black squares, followed by the text "Visual Patterns" in a cursive font. Below the logo is a navigation menu with links for various pattern ranges: 1-20, 21-40, 41-60, 61-80, 81-100, 101-120, 121-140, 141-160, 161-180, 201-220, 221-240, 241-260, 261-280, TEACHERS, GALLERY, and CONTACT. Below the navigation menu is a prompt: "Click on a pattern to see a larger image and the answer to step 43. What is the equation?". Underneath the prompt is a grid of eight pattern thumbnails. The second thumbnail in the top row shows a sequence of four 3D block patterns labeled 2, 3, 4, and 5. The first pattern (step 2) has 4 blocks, the second (step 3) has 7 blocks, the third (step 4) has 10 blocks, and the fourth (step 5) has 13 blocks.

- › Sketch the next three images.
- › How many blocks are there in step 43?



A close-up view of the 3D block pattern sequence. It shows four steps labeled 1, 2, 3, and 4. Step 1 has 1 block. Step 2 has 4 blocks. Step 3 has 7 blocks. Step 4 has 10 blocks. Below the sequence, the text reads: "Pattern #2, Blocks in step 43 = 85".

Fluid Reasoning Index (FRI)

Definition:

“The ability to use logic to solve unfamiliar problems.”
(Flanagan, 2017, p. 35)

Subtest:

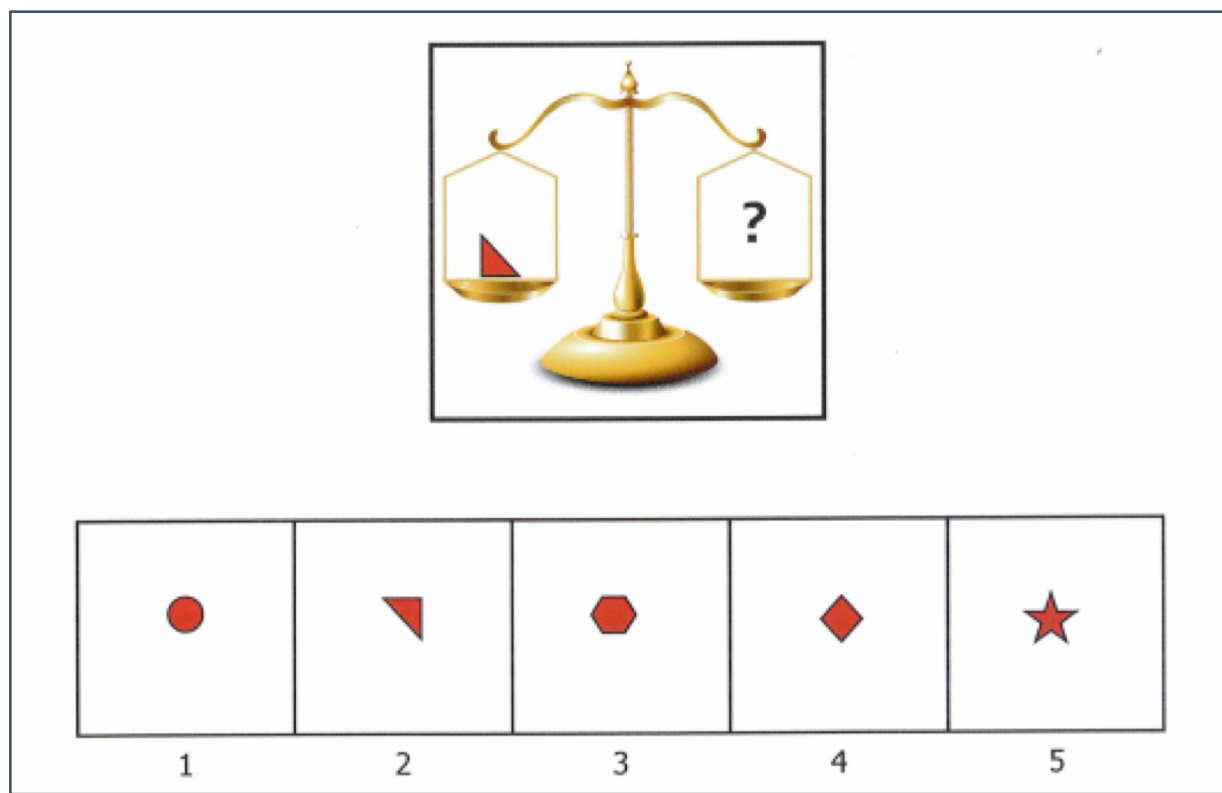
Figure Weights

Impact on Mathematics:

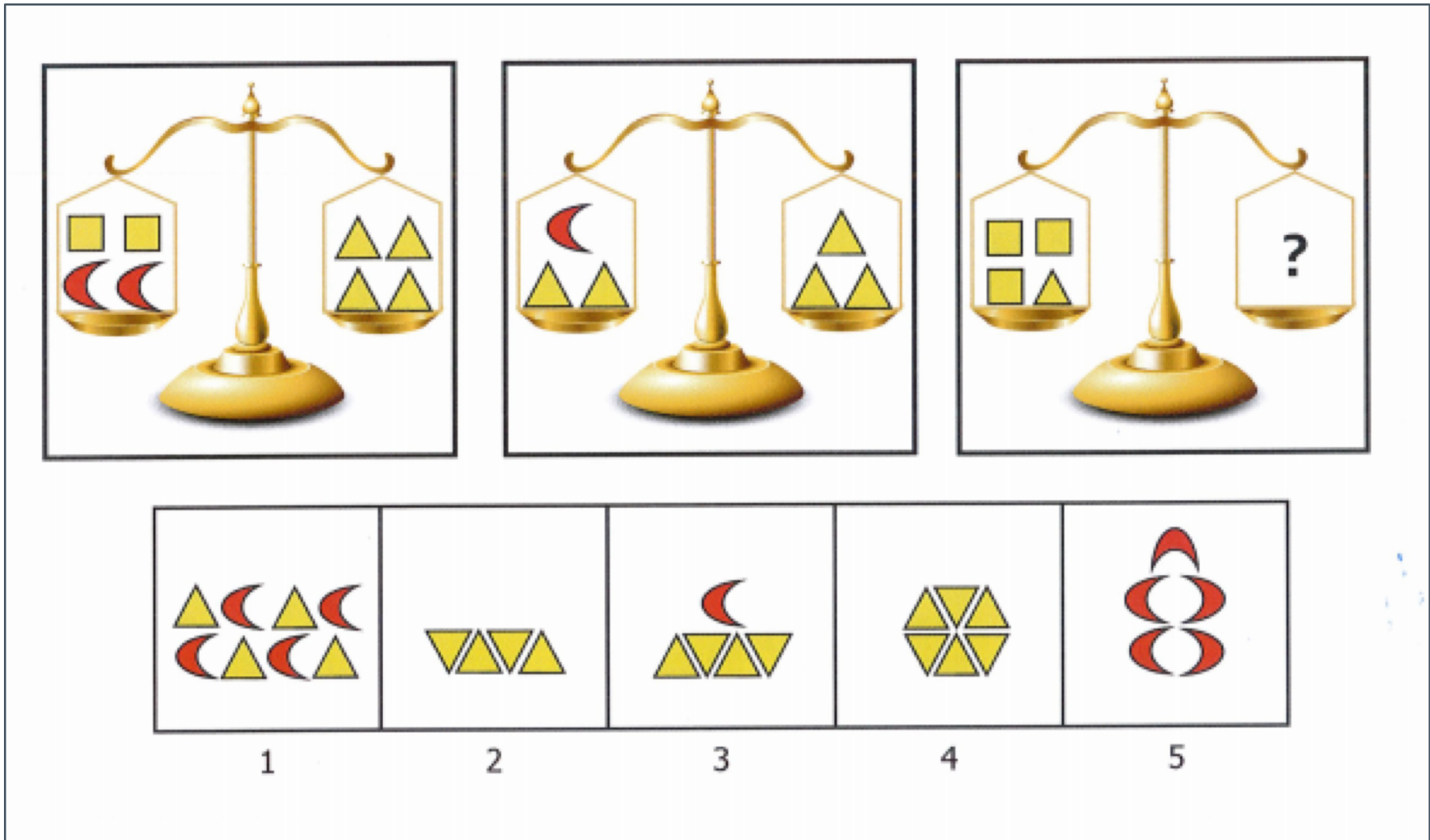
*Understanding Mathematical Concepts and Relationships;
Algebra; Deductive and Quantitative Reasoning

Figure Weights

› Given a specific time limit – determine:



Sample test items taken from:
Preparation Workbook for the WISC-V Test (Publishing, 2015)



Support: Estimation 180 – Andrew Stadel

WHAT DO YOU THINK?

[HTTP://WWW.ESTIMATION180.COM/](http://www.estimate180.com/)

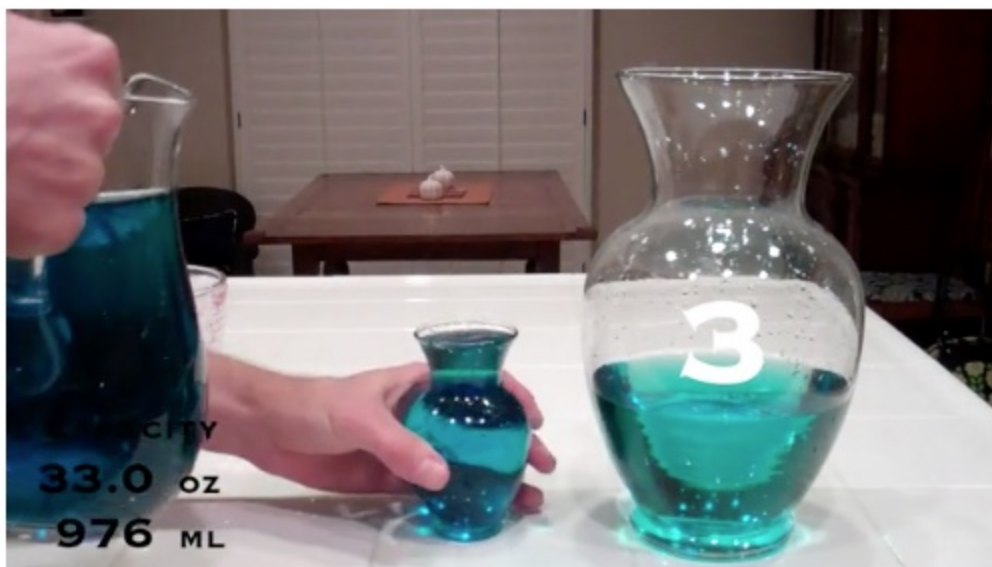
- › How many small vases will it take to fill the large vase?
- › How would you test your guess?



π

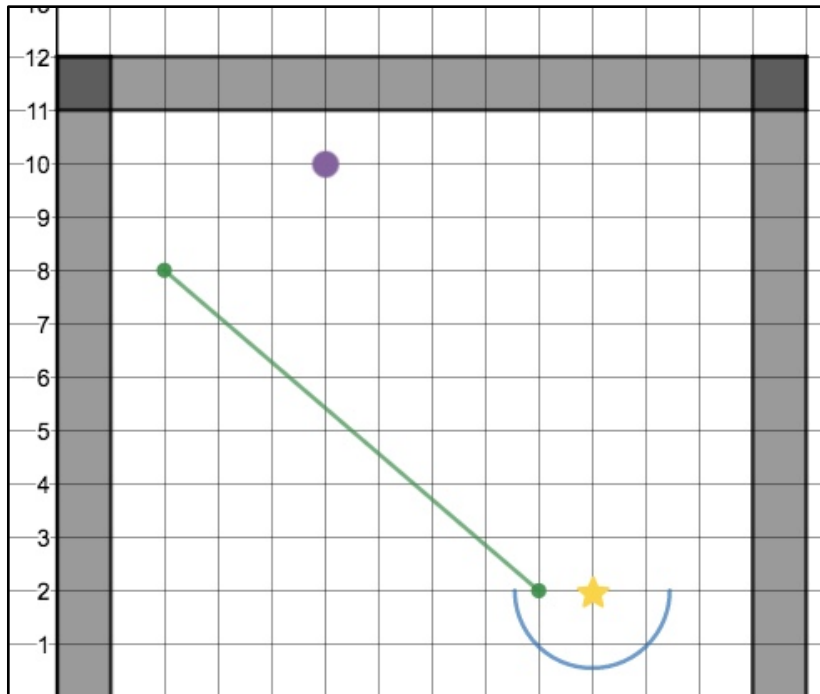
Estimation 180

Answer:

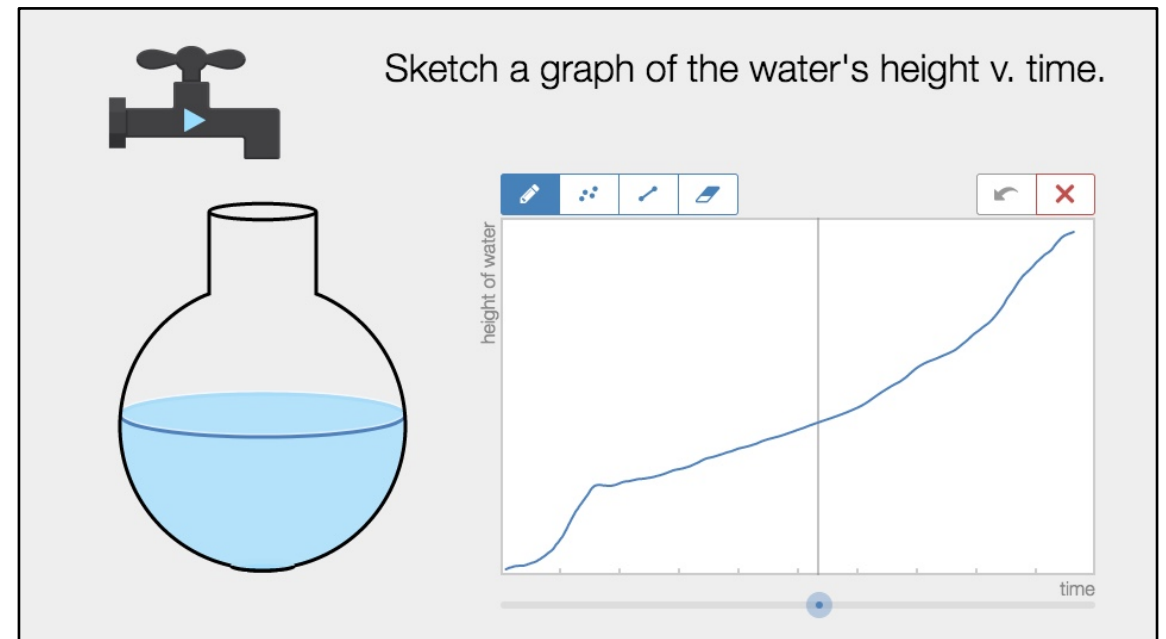


Desmos Activities – Dan Meyer and team
Our Host: Leigh Nataro – Desmos Fellow/Certified Presenter!

› Marble Slide



› Water Line



Working Memory Index (WMI)

Definition:

“The ability to maintain and manipulate information in short term memory in order to solve multistep problems.” (Flanagan, 2017, p. 37)

Subtest:

Digit Span

Impact on Mathematics:

*Numeracy, representation, and one-to-one correspondence; procedural fluency with multistep problems.

Digit Span

› Three Parts:

- Digit Span **Forward**: 2-3-6-8 **Ans: 2-3-6-8**
- Digit Span **Backward**: 2-1-8-3 **Ans: 3-8-1-2**
- Digit Span **Sequence**: 5-3-9-2 **Ans: 2-3-5-9**

Digit Span – Let's Try It!

› Three Parts:

#1 Digit Span **Forward**:

#2 Digit Span **Backward**:

#3 Digit Span **Sequence**:

Digit Span – How did you do?

› Three Parts:

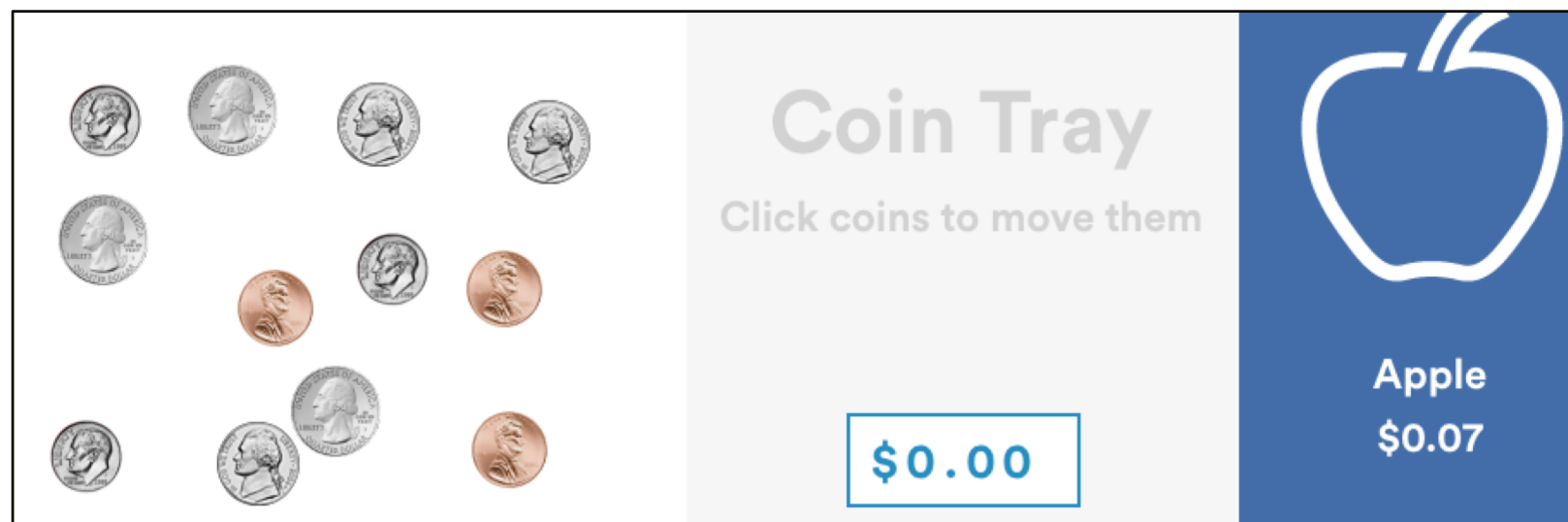
#1 Digit Span **Forward**: 1-4-2-8-6-9 **Ans: 1-4-2-8-6-9**

#2 Digit Span **Backward**: 4-2-8-9-3-5 **Ans: 5-3-9-8-2-4**

#3 Digit Span **Sequence**: 3-9-0-1-7-2-6 **Ans: 0-1-2-3-6-7-9**

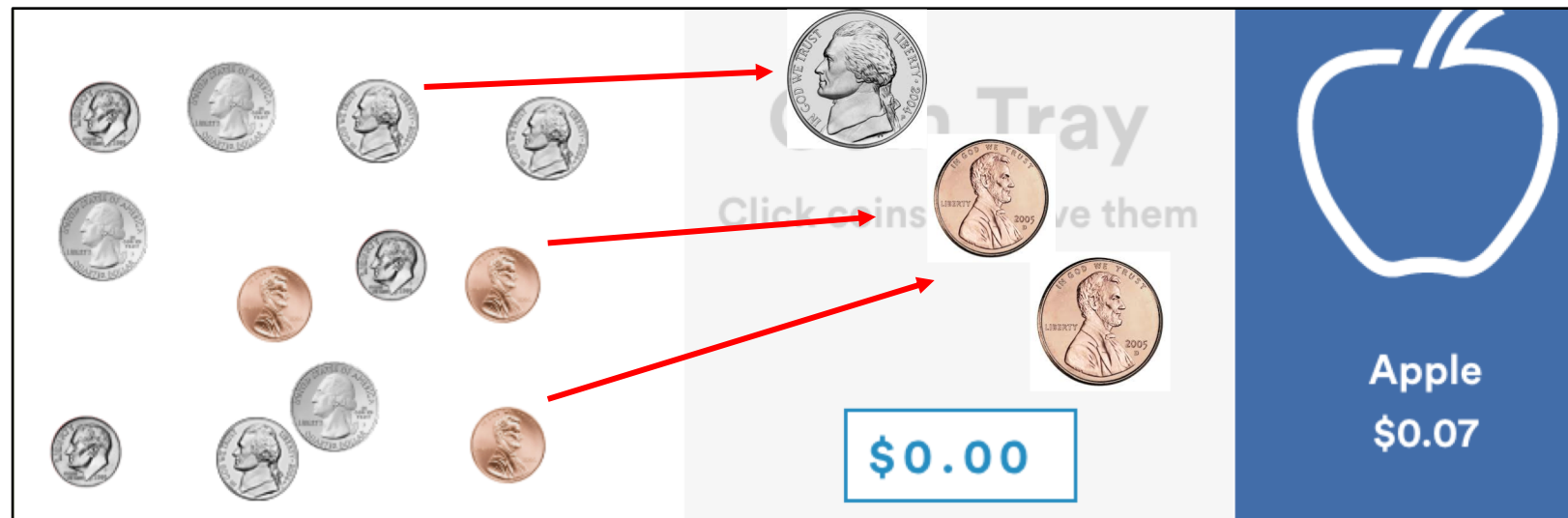
What would it feel like?

- › Simulation: From Understood.org
- › <https://u.org/1qOLNXk>



Support and Information: Understood.org

- › Simulation:
- › <https://u.org/1qOLNXk>



π

Problem #1:



The screenshot displays the 'Coin Tray' app interface. At the top, a purple bar contains four selected coins with their values: 29¢, 7¢, 13¢, and 34¢. Below this, a white area shows a collection of loose coins. To the right, a grey panel displays the title 'Coin Tray' and the instruction 'Click coins to move them'. At the bottom of this panel, a blue box shows the current total value: '\$0.00'. On the far right, a blue panel shows a clock icon and the time '1:16', a white outline of an Apple logo, and the text 'Apple \$0.07'.

Problem #1: Solution

The screenshot shows an iPhone interface for a 'Coin Tray' app. On the left, a purple tray contains four coins with their values: 29¢ (quarter), 7¢ (penny), 13¢ (nickel), and 34¢ (quarter). Below this is a collection of loose coins. A red arrow points from the purple tray to a single coin in the 'Coin Tray' area. The 'Coin Tray' area is light gray and contains the text 'Coin Tray' and 'Click coins to move them'. Below this is a blue box with '\$0.00'. On the right, a blue sidebar shows a clock at 1:16, the Apple logo, and the text 'Apple \$0.07'. A large red arrow on the left points towards the purple tray.

Problem #2:



29¢ 7¢ 13¢ 34¢

Coin Tray
Click coins to move them

\$0.00

0:10

Milk
\$0.83

Problem #2: Solution

Dime = 34¢
Nickle = 7¢
Penny = 29¢
Quarter = 13¢

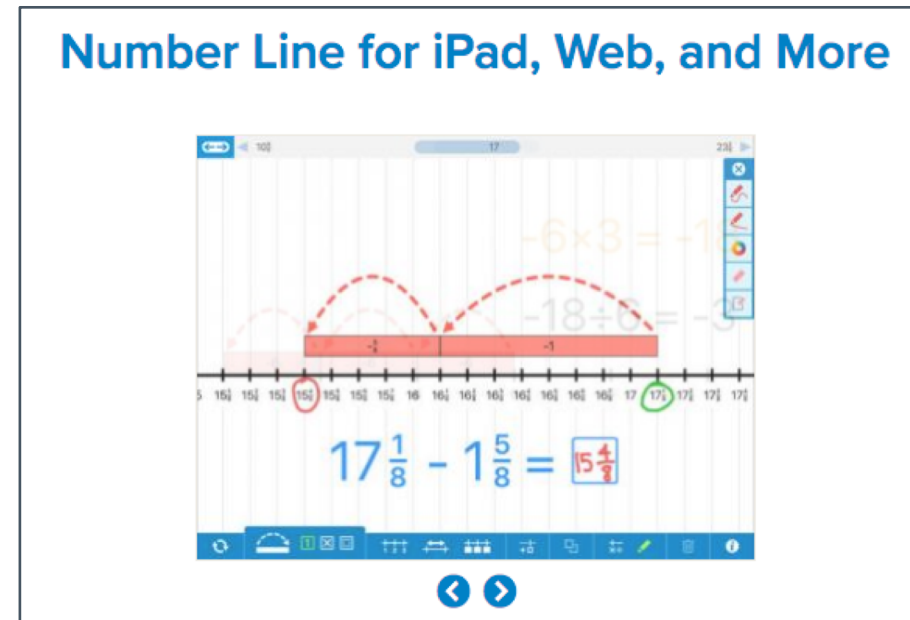
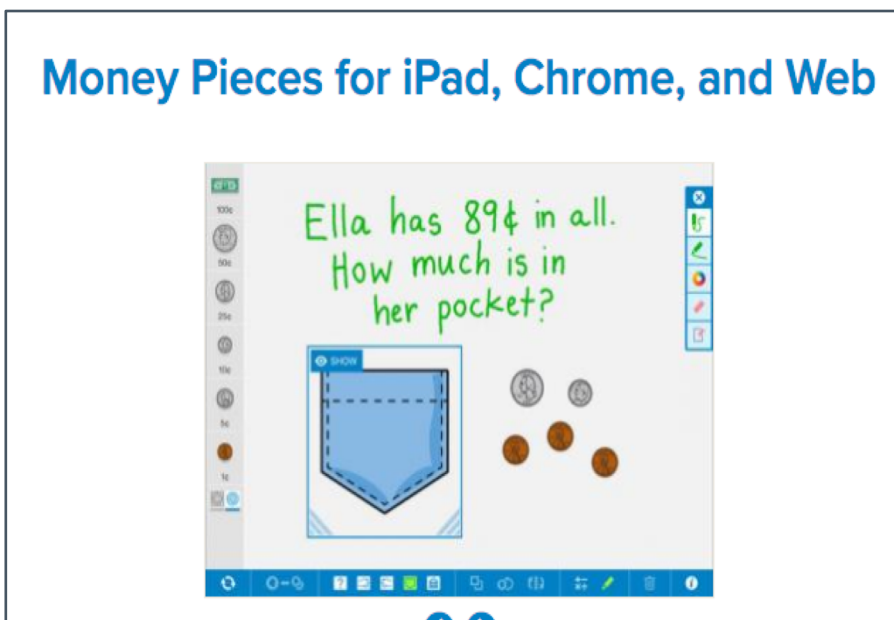
Total = 83¢



The screenshot shows a digital interface for a coin tray. On the left, a purple header lists coin values: Dime (34¢), Nickle (7¢), Penny (29¢), and Quarter (13¢). Below this, a tray contains several coins: two pennies, three quarters, and one dime. On the right, a grey panel titled "Coin Tray" contains the instruction "Click coins to move them" and a blue box displaying "\$0.83". To the right of the tray is a blue panel showing a clock at 0:35, a milk carton icon, and the text "Milk \$0.83".

Support and Information:

- › The Math Learning Center – Free Apps



Processing Speed Index (PSI)

Definition:

This is about output – performance. How efficiently one is able to produce.

“The ability to fluently deploy the focus of one’s attention to process information quickly.” (Flanagan, 2017, p. 39)

Subtest:

Coding

Impact on Mathematics:

› **Working with mathematical symbols (Algebra) and real-world tasks (money)

Coding

- › 120 seconds (not 1 minute 20 seconds).
- › Score one point for correct items.

A	B	C	D	E	F	G	H	I
○	△	∋	⊙	=	⊥	:	>	⊖

Practice Items:

D	B

Sample test items taken from:
Preparation Workbook for the WISC-V Test (Publishing, 2015)

KEY

A	B	C	D	E	F	G	H	I
○	△	☉	⊙	=	⊥	:	>	⊖

Practice Items:

D	B

C	E	D	I	A	F	H	E	D	I	B	A	H	B	E	D	F	I	A	C

A	G	B	I	C	D	E	D	C	H	A	F	E	G	I	A	H	F	I	D

B	F	A	H	B	I	D	G	F	E	A	B	H	G	C	E	H	D	A	E

D	I	G	E	H	A	F	D	E	H	G	I	A	B	C	I	E	B	C	D

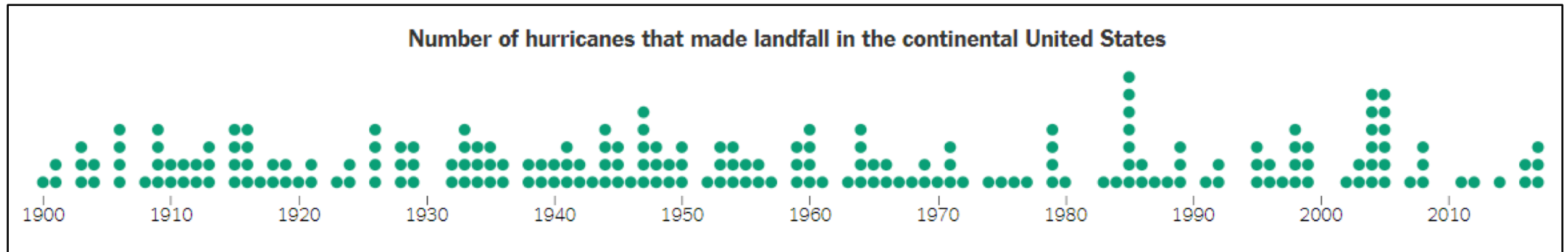
F	A	I	E	G	F	C	H	I	G	B	F	D	E	A	I	G	E	B	H

I	B	G	E	A	D	E	I	G	B	C	F	A	H	G	D	I	A	B	F

Time (Max. 120 sec.) _____ Total Correct _____ % Correct _____
 _____ /120 x 100= _____

Support: Annie Fetter – New York Times

- › What's Going On in This Graph?
- › <https://www.nytimes.com/column/whats-going-on-in-this-graph>

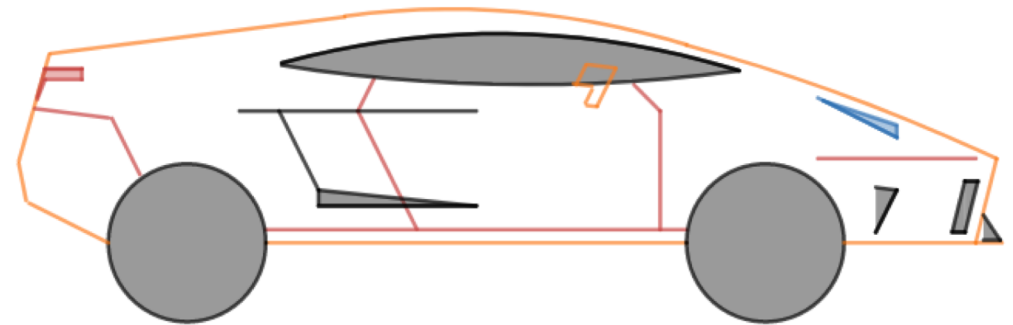


C. How can we help?

- Embrace Mathematics
- Share a Positive Attitude and Know that Challenge is Critical
- Promote Curiosity
- Think Mathematically
- Ask Questions “What do you notice, wonder, think?”

Student Story...Processing Speed – Output.

- › Engage students at a high academic level by attending to mathematical precision, language, and ideas.
- › Students can be mathematically creative.



Desmos Math Art Project
– by Zach Weiland

Mathematical Tasks...

LOW FLOOR HIGH CEILING

- › Accessible
- › Interesting and Engaging
- › About the Process
- › Mathematical Thinking

FOUR 4's Puzzle

Numbers from 1 - 20; 1 - 100

$$\frac{4 + 4}{4 + 4} = \frac{8}{8} = 1$$

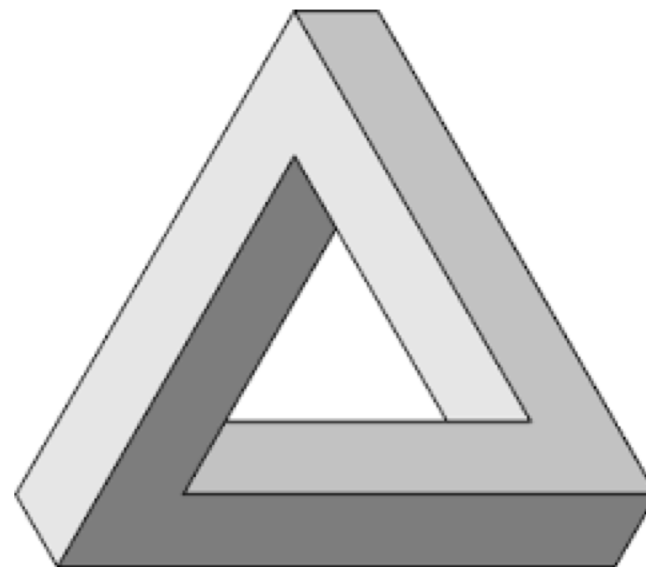
$$4 \cdot 4 + \sqrt{4} + \sqrt{4} = 20$$

Taken from Jo Boaler
Mathematical Mindsets page 80.

Closing and Reflection:

DURING THESE TIMES...IN THE CHAT PLEASE SHARE:

- › What is one way you are promoting mathematical thinking with your students?
- › What is one way you are working to build relationships with your students?



$$P_{ni} \left(x_{ni} = \frac{1}{B_n}, D_i \right) = \frac{e^{(B_n - D_i)}}{1 - e^{(B_n - D_i)}}$$

Presentation Slides at:

<https://www.mathsforallradair.org/>

Thank you! Questions?

Mindy Adair, Ph.D.

Director of Mathematics - Denver Academy

madair@denveracademy.org @AdairMindy

