

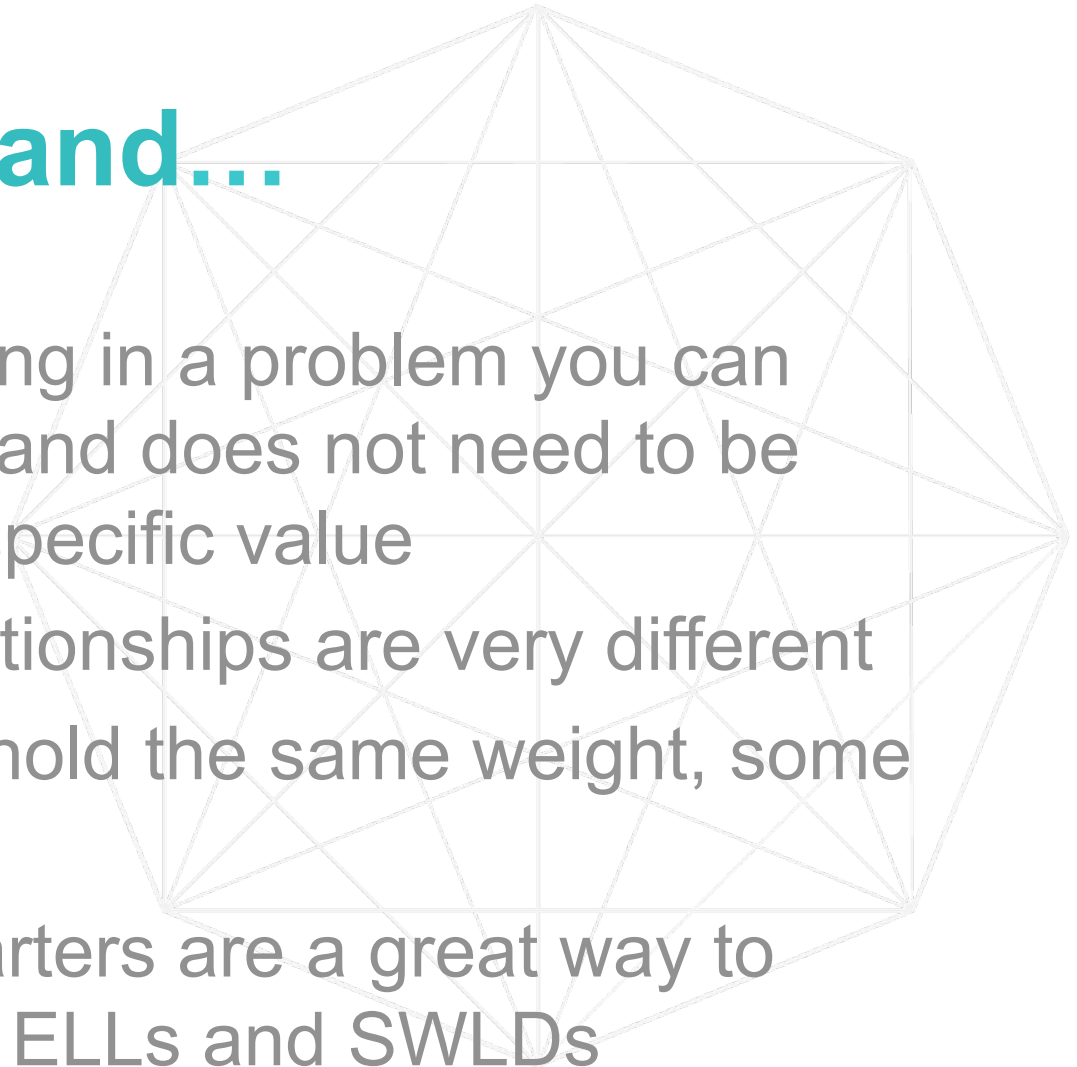
I'm Thinking differently about...



- Helping students read math problems
- The way I teach my students to diagram
- Scaffolding
- Quantities and relationships, i.e. how to be more precise about them
- How to introduce problem solving at the beginning of the year, i.e. through routines
- PD for my district. It should be focused on instructional routines vs. products/curriculum

I now understand...

- A quantity is anything in a problem you can count or measure, and does not need to be associated with a specific value
- Quantities and relationships are very different
- Not all of the MPs hold the same weight, some support others
- Using sentence starters are a great way to reinforce vocab for ELLs and SWLDs



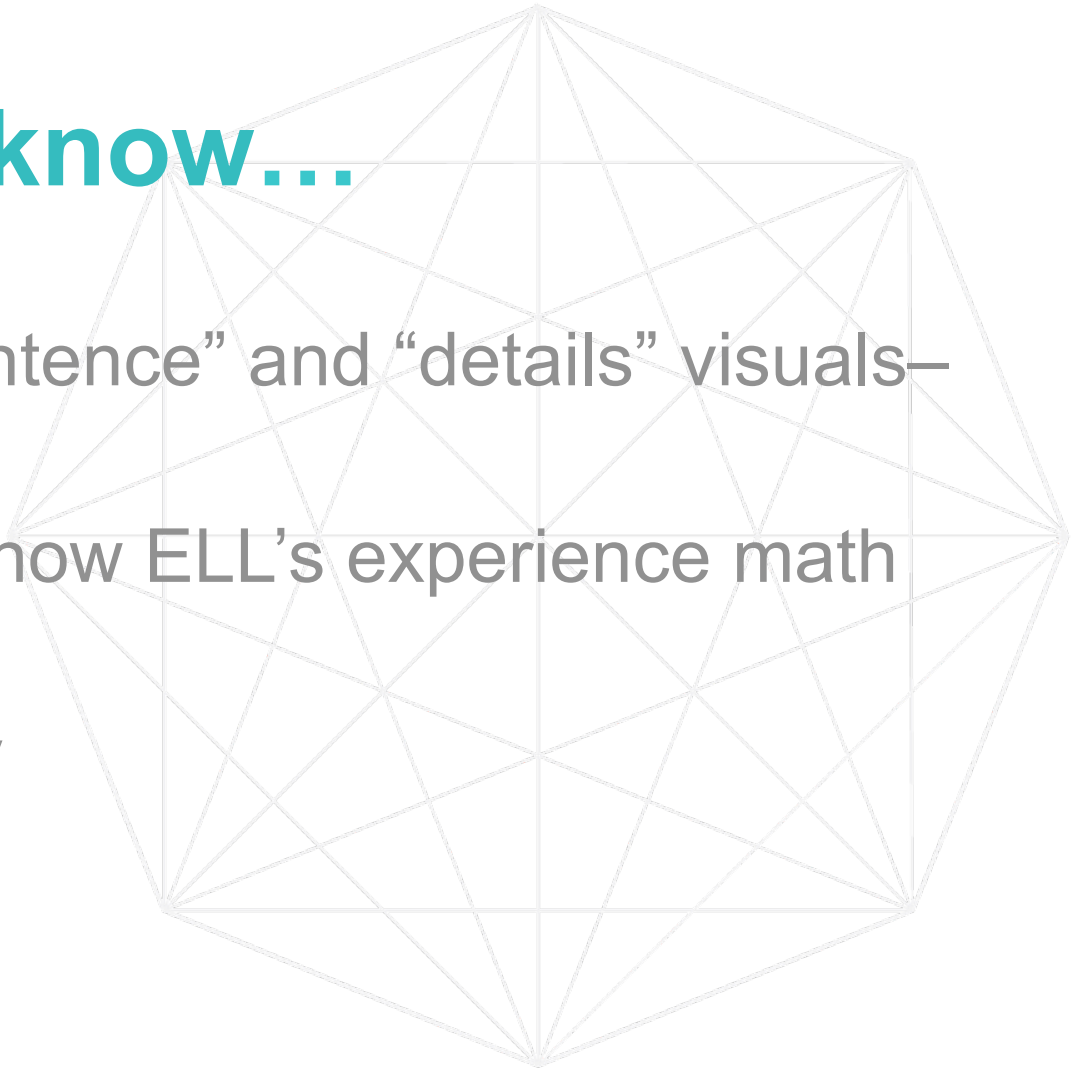
A Question I have..



- How long does a routine take? Does an intro lesson differ from a 5th or 6th in terms of length?
- Do you have any templates/student materials?
- Where to find/ how to select tasks for routines?
- How common is it for teachers to use these routines?
- Do you change the routine based on grade level?
- How to differentiate for students who are able to complete these tasks quickly and adeptly?

I want you to know...

- I love the “topic sentence” and “details” visuals—very helpful.
- I’m still wondering how ELL’s experience math practices
- Great pacing today



Fostering the Mathematical Practices in English Learners and Students with Learning Disabilities

Grace Kelemanik
Amy Lucenta



#FosteringMPs
@GraceKelemanik
@AmyLucenta



FOSTERING
MATH
PRACTICES

www.fosteringmathpractices.com

Share...discuss...reflect..



#FosteringMPs

@AmyLucenta

@GraceKelemanik

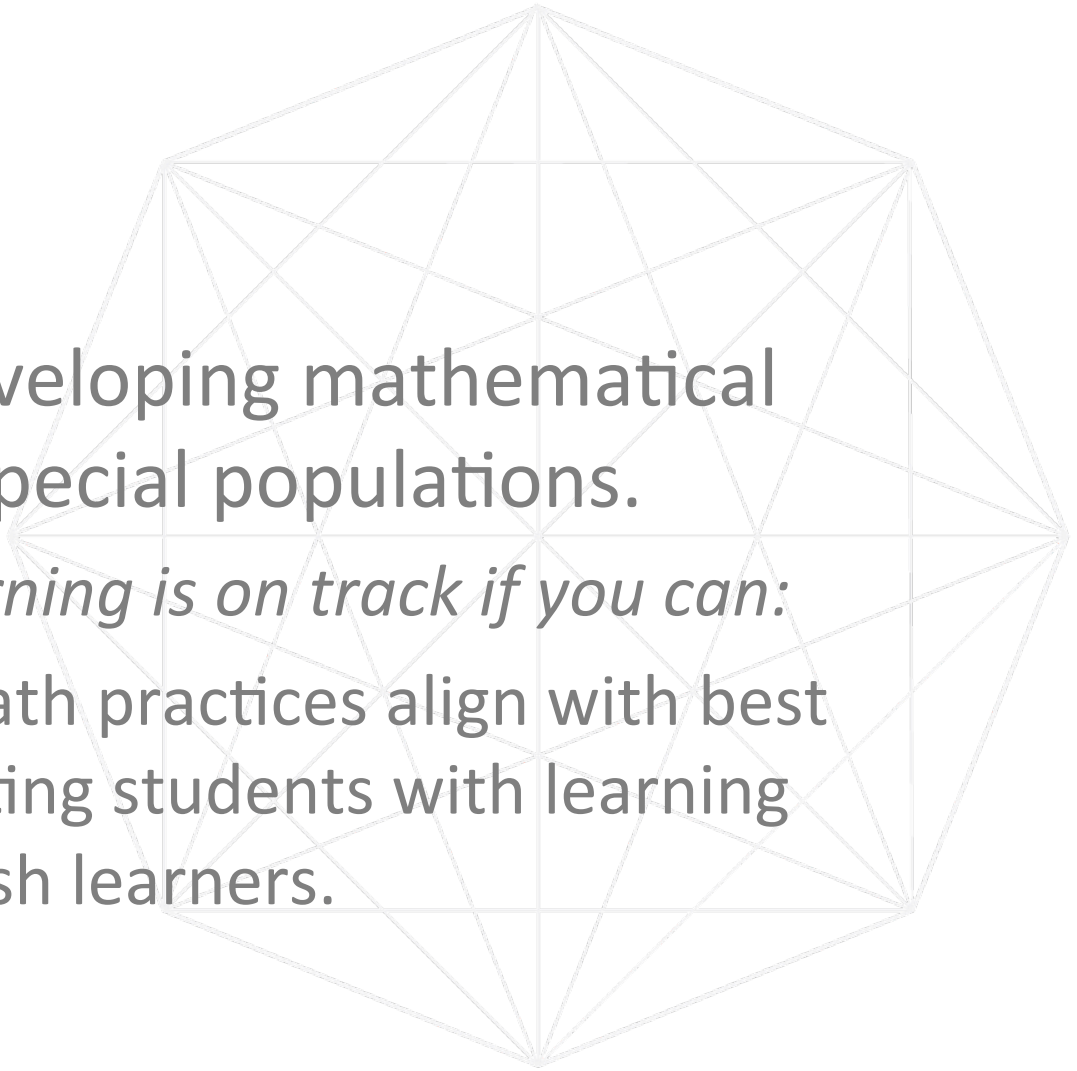
www.fosteringmathpractices.com

Goal # 1

Understand how developing mathematical practices supports special populations.

You will know your learning is on track if you can:

- Describe how the math practices align with best practices for supporting students with learning disabilities and English learners.

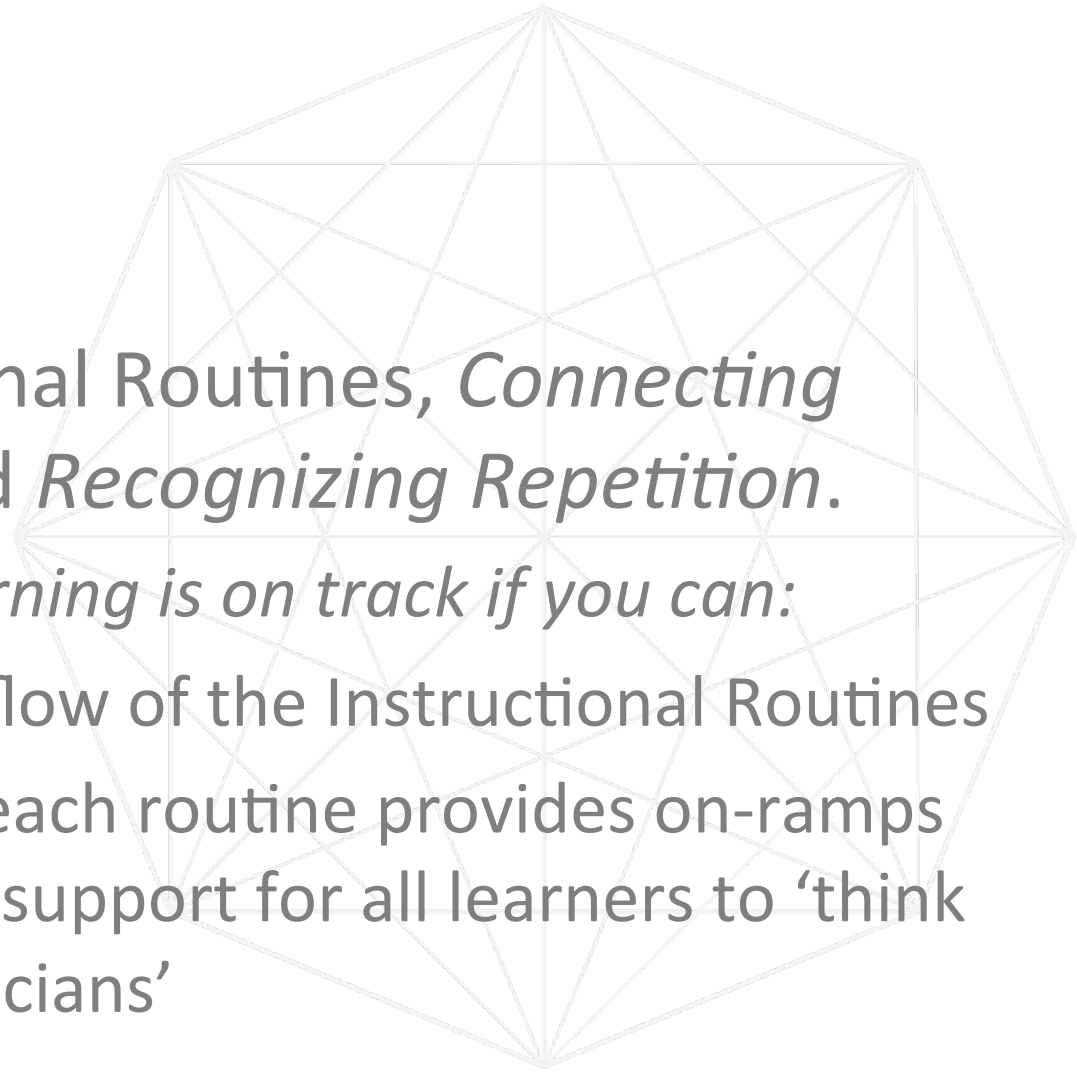


Goal # 2

Learn the Instructional Routines, *Connecting Representations* and *Recognizing Repetition*.

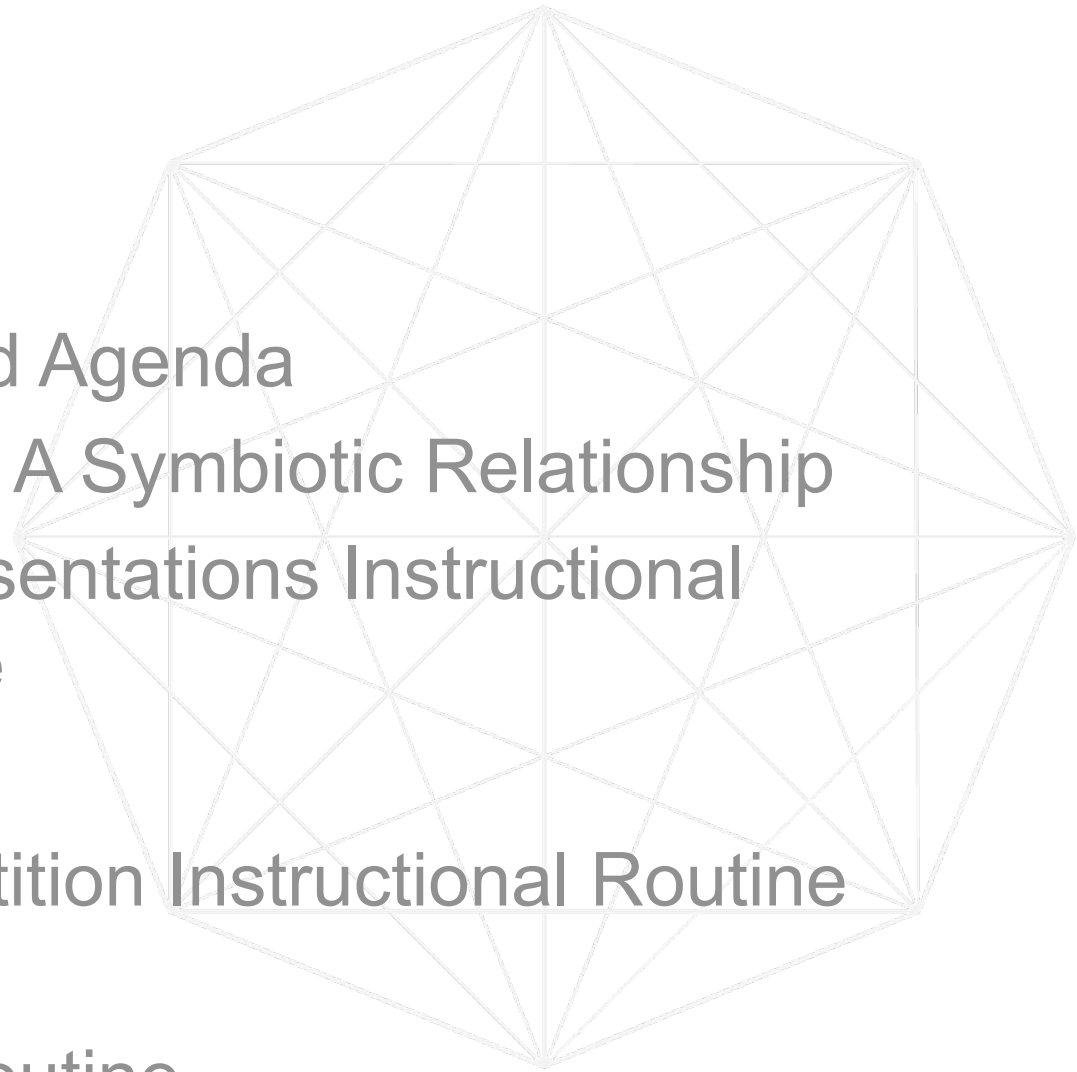
You will know your learning is on track if you can:

- Articulate the flow of the Instructional Routines
- Describe how each routine provides on-ramps and continued support for all learners to ‘think like mathematicians’



Agenda

- Opening Goals and Agenda
- MPs and SpPops: A Symbiotic Relationship
- Connecting Representations Instructional Routine Deep Dive
- Lunch
- Recognizing Repetition Instructional Routine Deep Dive
- Select a 'Focus' Routine
- Wrap Up and Adjourn





MATH PRACTICES

- An essential goal for all?*
- A critical support for special populations?.*

MATH PRACTICES

MP4

Model

MP8

Repetition

MP3

Construct &
critique

MP7

Structure

MP2

Reason
quantitatively

MP6

Precision

MP1

Make sense &
persevere

MP5

Tools



MATH PRACTICES



MATH PRACTICES







MP 1 MP 2 MP 3

MP 5
MP 4

MP 8
MP 7
MP 6





WORK WITHIN CONTEXTS

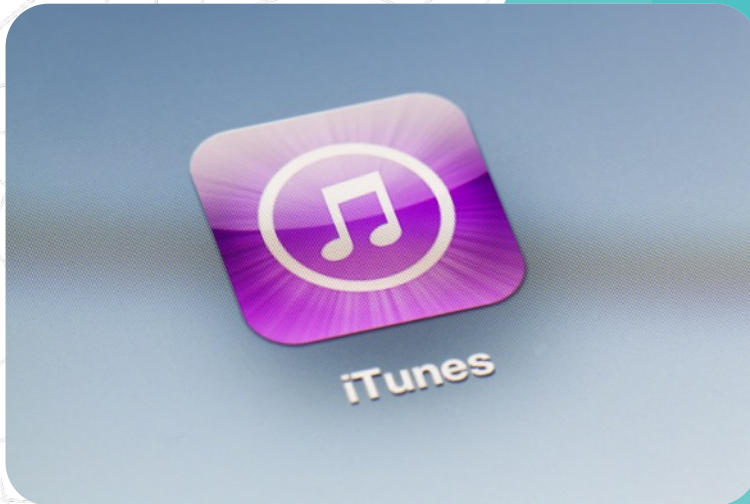
MP1 MP2 MP4

WORK WITHIN CONTEXTS

$$\begin{array}{r} 25 \\ \times 9 \\ \hline \end{array}$$



WORK WITHIN CONTEXTS





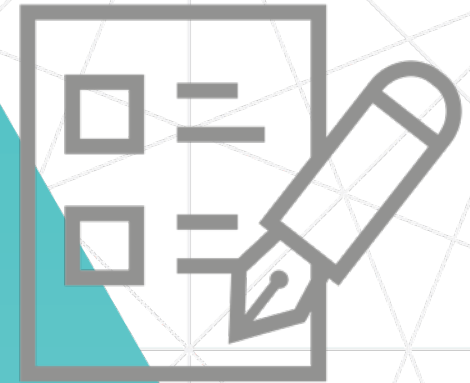
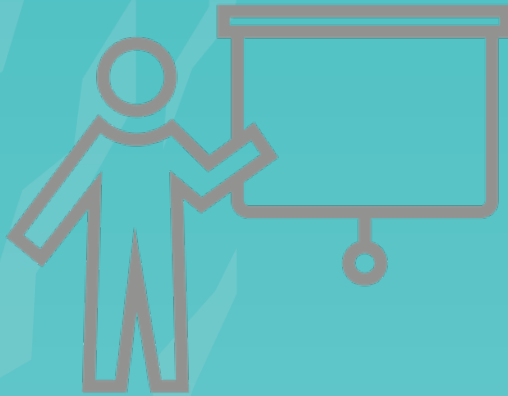
COMMUNICATE IDEAS

MP1 MP3 MP6

COMMUNICATE IDEAS



COMMUNICATE IDEAS





CONNECT IDEAS & REPRESENTATIONS

MP2 MP4 MP5 MP7

CONNECT IDEAS & REPRESENTATIONS

$$\frac{5}{4}$$



five fourths



CONNECT IDEAS & REPRESENTATIONS



ABSTRACT & GENERALIZE

MP2 MP7 MP8

The background features a large teal shape with a jagged top edge, resembling a mountain or a stylized letter 'A'. This shape is overlaid on a light gray wireframe structure of a dodecahedron. The wireframe is composed of thin lines forming a complex geometric pattern.

ABSTRACT & GENERALIZE

MP2
Quantitative Reasoning

MP7
Structural Thinking

MP8
Repeated Reasoning

MP1 PERSEVERANCE

MP2
Quantitative Reasoning

MP7
Structural Thinking

MP8
Repeated Reasoning

A SYMBIOTIC RELATIONSHIP



TEACH MATH
PRACTICES
AUTHENTICALLY

SUPPORT
SPECIAL
POPULATIONS

SWLD

ELL

Work within contexts

Opportunities to communicate ideas

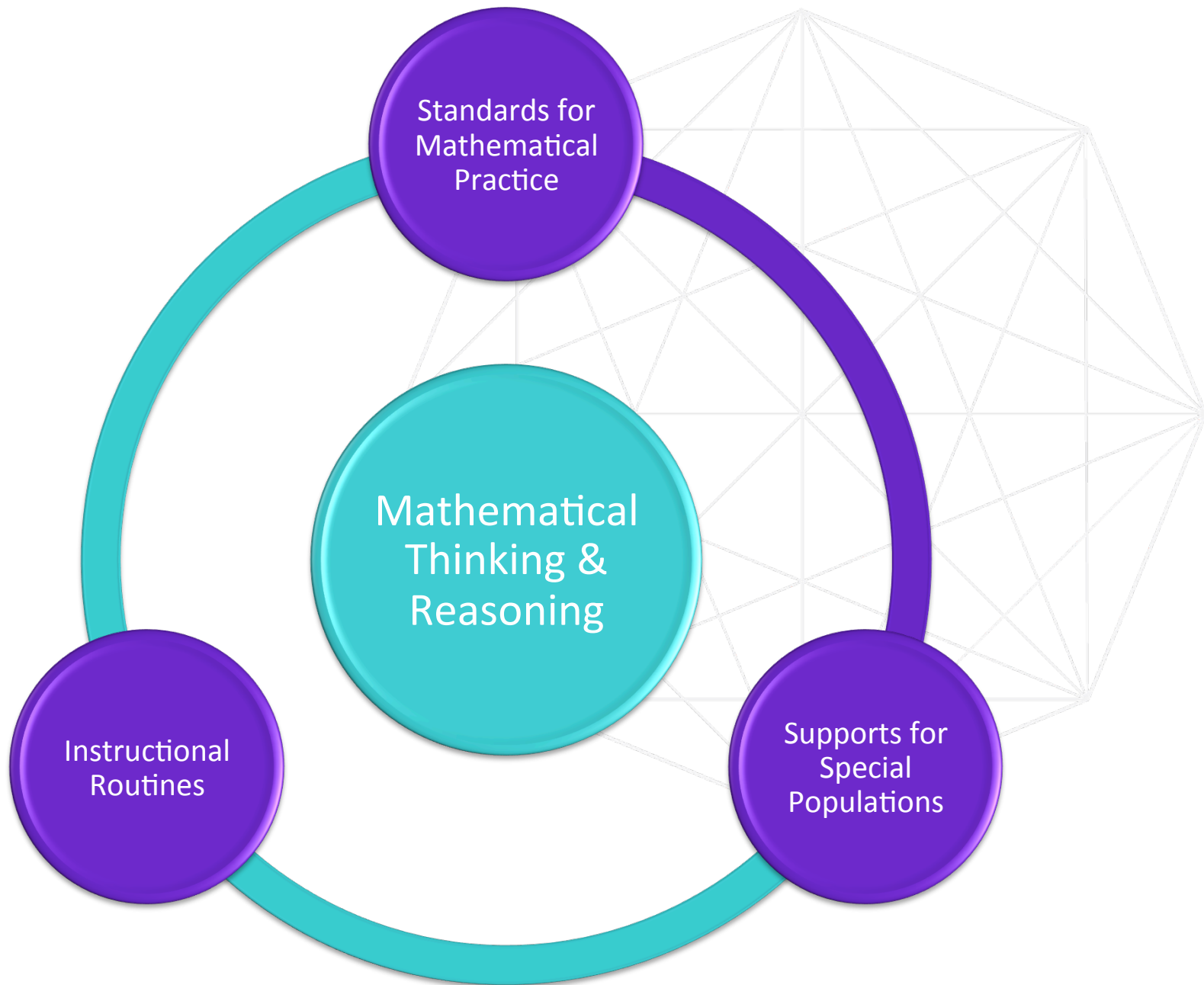
Multisensory learning experiences

Connect ideas & representations

Opportunities for multiple strategies

Multiple practice opportunities for students to develop mathematical understanding

Carefully planned range & sequence of examples



Standards for
Mathematical
Practice

Mathematical
Thinking &
Reasoning

Instructional
Routines

Supports for
Special
Populations

SWLD

ELL

Work within contexts

Opportunities to communicate ideas

Multisensory learning experiences

Connect ideas & representations

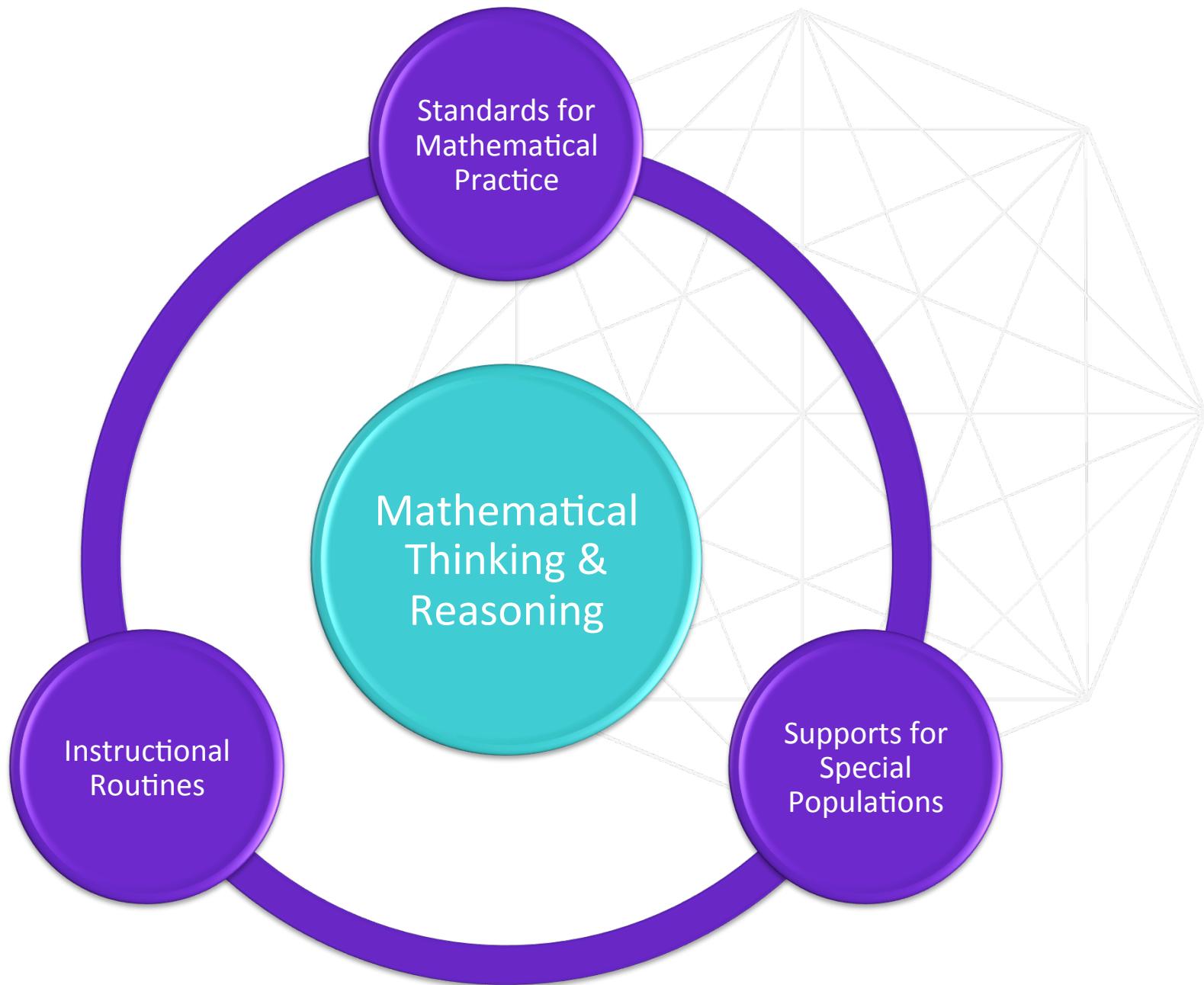
Opportunities for multiple strategies

Multiple practice opportunities for students to develop mathematical understanding

Carefully planned range & sequence of examples



**HOW ARE INSTRUCTIONAL ROUTINES
SUPPORTS for
SPECIAL POPULATIONS?**



Standards for
Mathematical
Practice

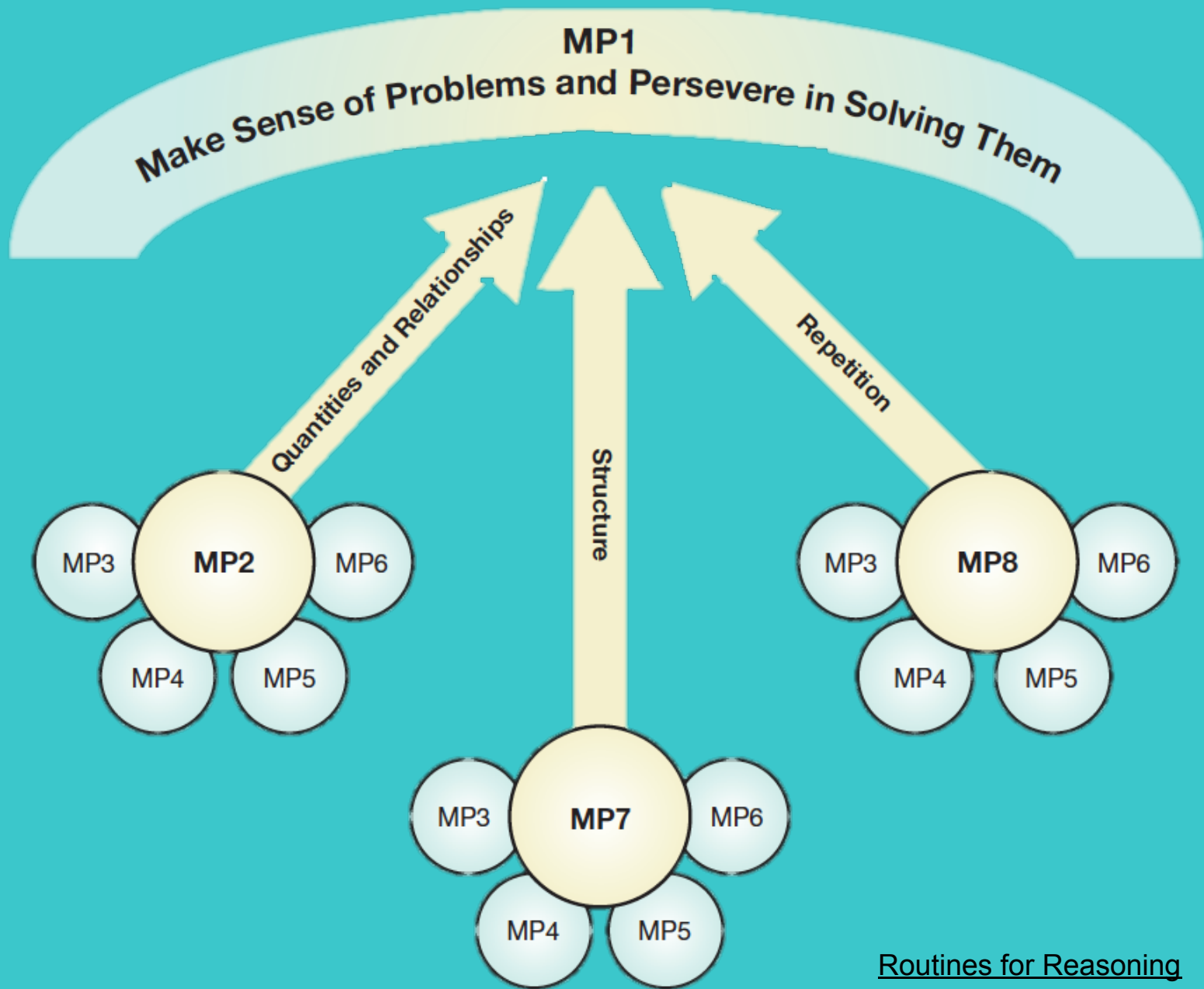
Mathematical
Thinking &
Reasoning

Instructional
Routines

Supports for
Special
Populations

So...an instructional routine that focuses on one or more avenues of thinking, and has 'baked-in', research-based supports for special populations...





Quantitative Reasoning supports **ALL students....especially**

- Students who don't know where to begin to solve a word problem
- Students who struggle with multi-step problems
- Students who benefit from working within contexts
- Students who benefit from drawing/using visual representations

Structural Thinking supports ALL students....especially

- Get lost in details or tedious calculations
- Benefit from visual representations
- Benefit from connections between and among math ideas & representations
- Interpret the 'big picture' or shift perspective

Repeated Reasoning supports ALL students....especially

- Students who benefit from multiple modalities
- Students who struggle to abstract and generalize
- Students who work in organized and/or systematic ways
- Students who benefit from seeing how rules are developed

Developing mathematical practices requires high leverage teaching practices

Instructional Routines embody
NCTM effective teaching practices
and equitable practices for students,
teachers, and districts.

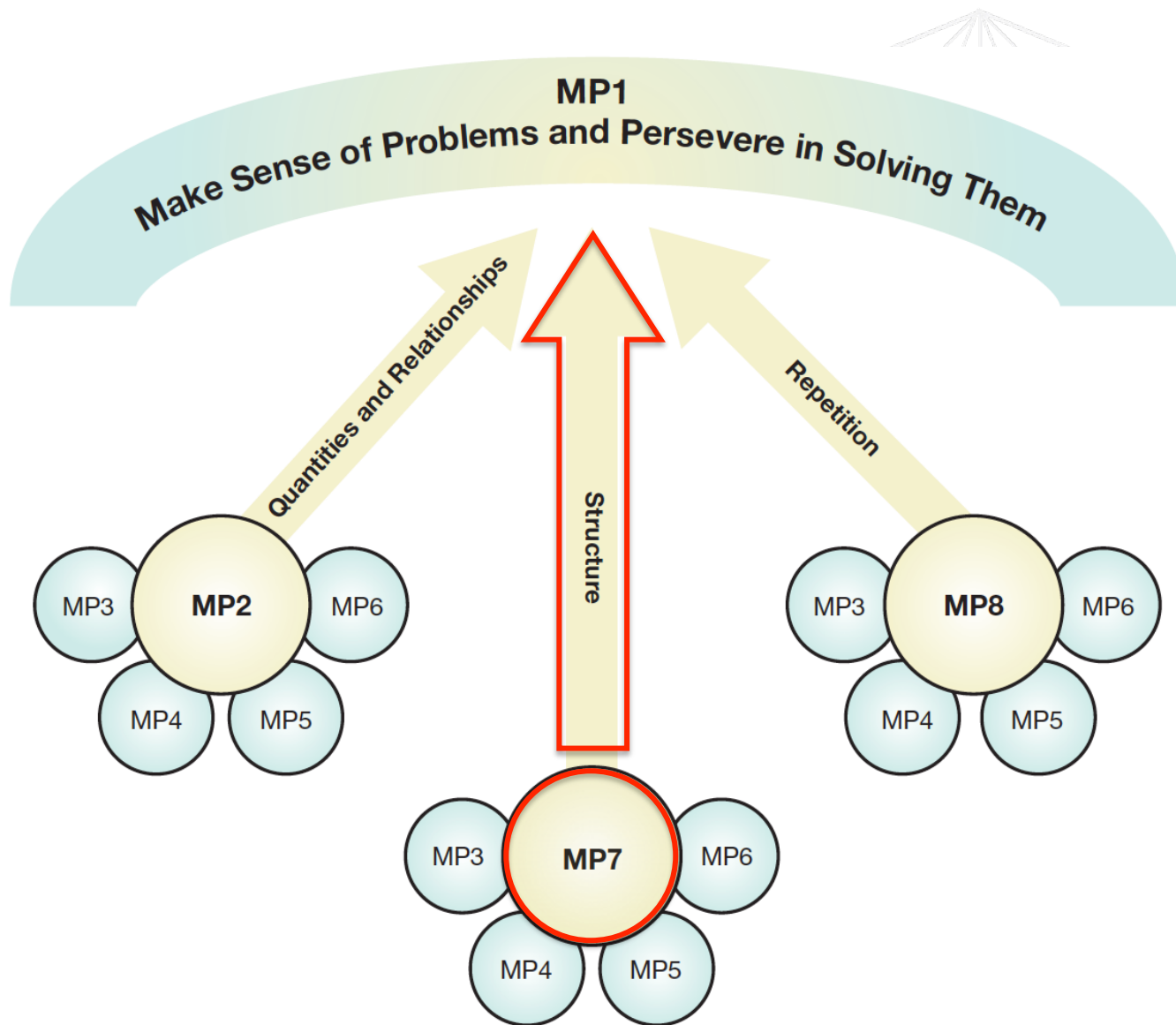


Figure 1.1 Diagram that shows the relationship of the practices to each other

Connecting Representations



An Instructional Routine to Develop
ALL Students' Structural Thinking



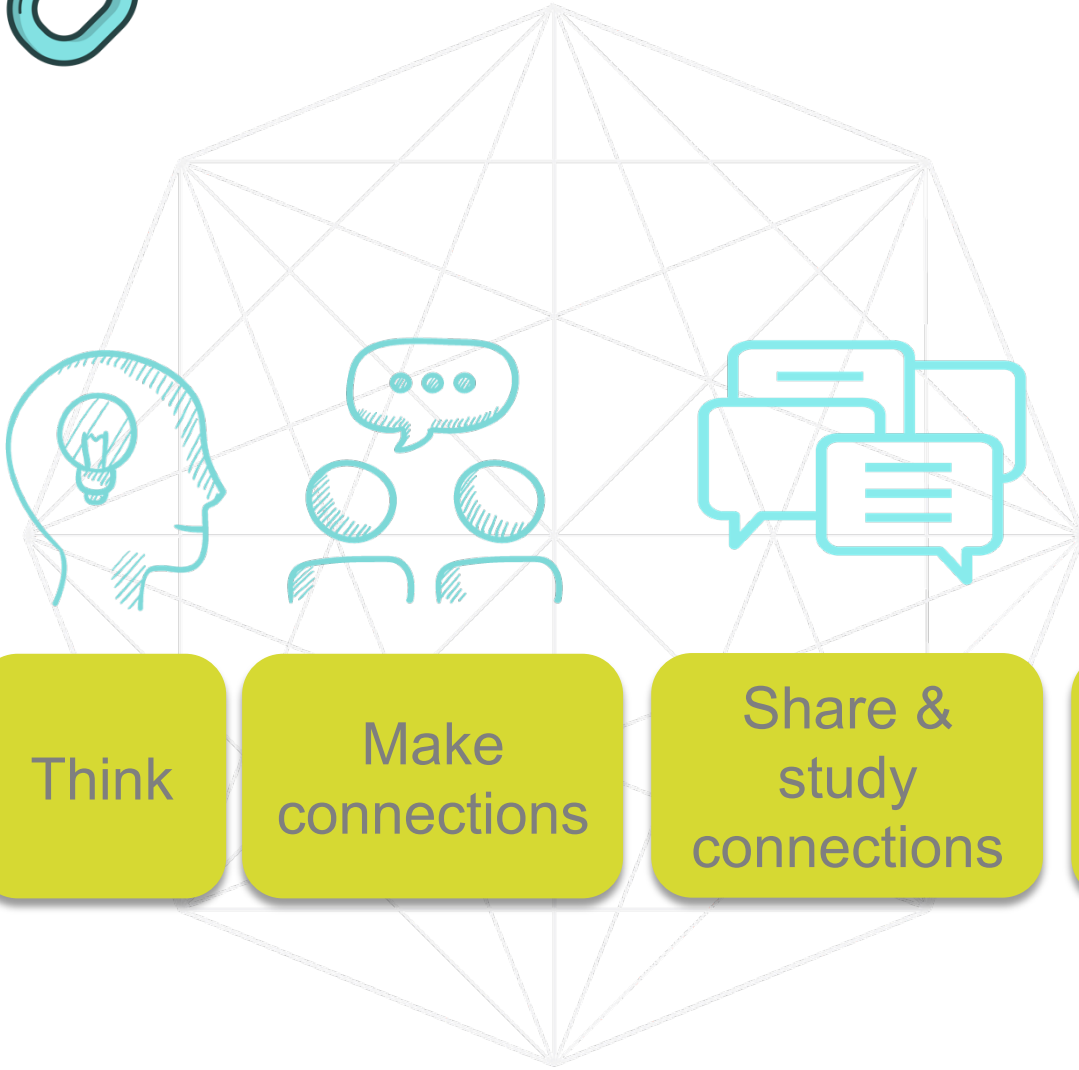
Connecting Representations

WHAT: Match visuals to expressions by **chunking**, **changing** the form, and **connecting** to math you know

WHY: To “think like mathematicians”, to use mathematical *structure* to match two different representations.



Connecting Representations



Think

Make
connections

Share &
study
connections



Create
representation



Reflect
on
learning



Think



Ask yourself...

- What part of the *visual* will help me connect to a chunk of the *expression*?
- What about the *expression* will help me connect to the *visual*?

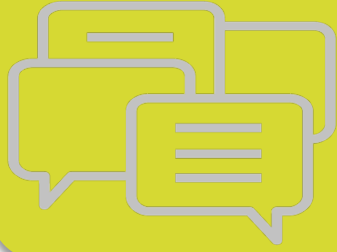


Make Connections

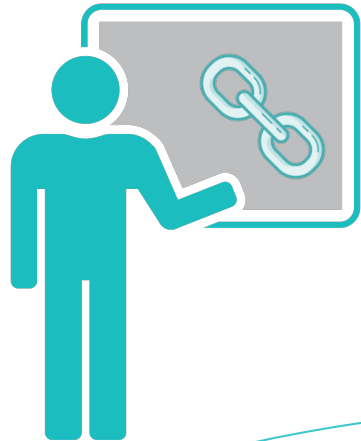


“I saw... so I connected...”

“... connects to ... because...”



Share & Study Connections



We noticed... so we ...
We knew... so we...

They noticed... so they ...
They knew... so they...



Create a Representation

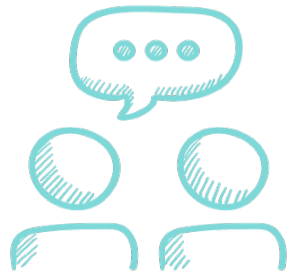


THINK

Ask yourself...

- “What do you notice about this *expression*?”
- “How can you chunk this *expression* into pieces you can describe?”

Create a Representation



Pair

- Share your interpretations of the *expression*.
- Together create a matching *visual representation*.

Create a Representation



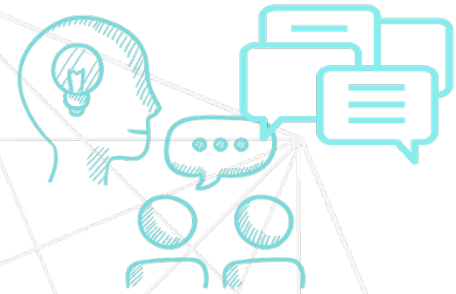
Share

They noticed... so they...

When they saw...it made them think of... so they...



Meta-Reflection



- A.** When interpreting an *expression / visual*, I learned to pay attention to...
- B.** When connecting representations, I learned to ask myself...
- C.** A new mathematical connection I made is...

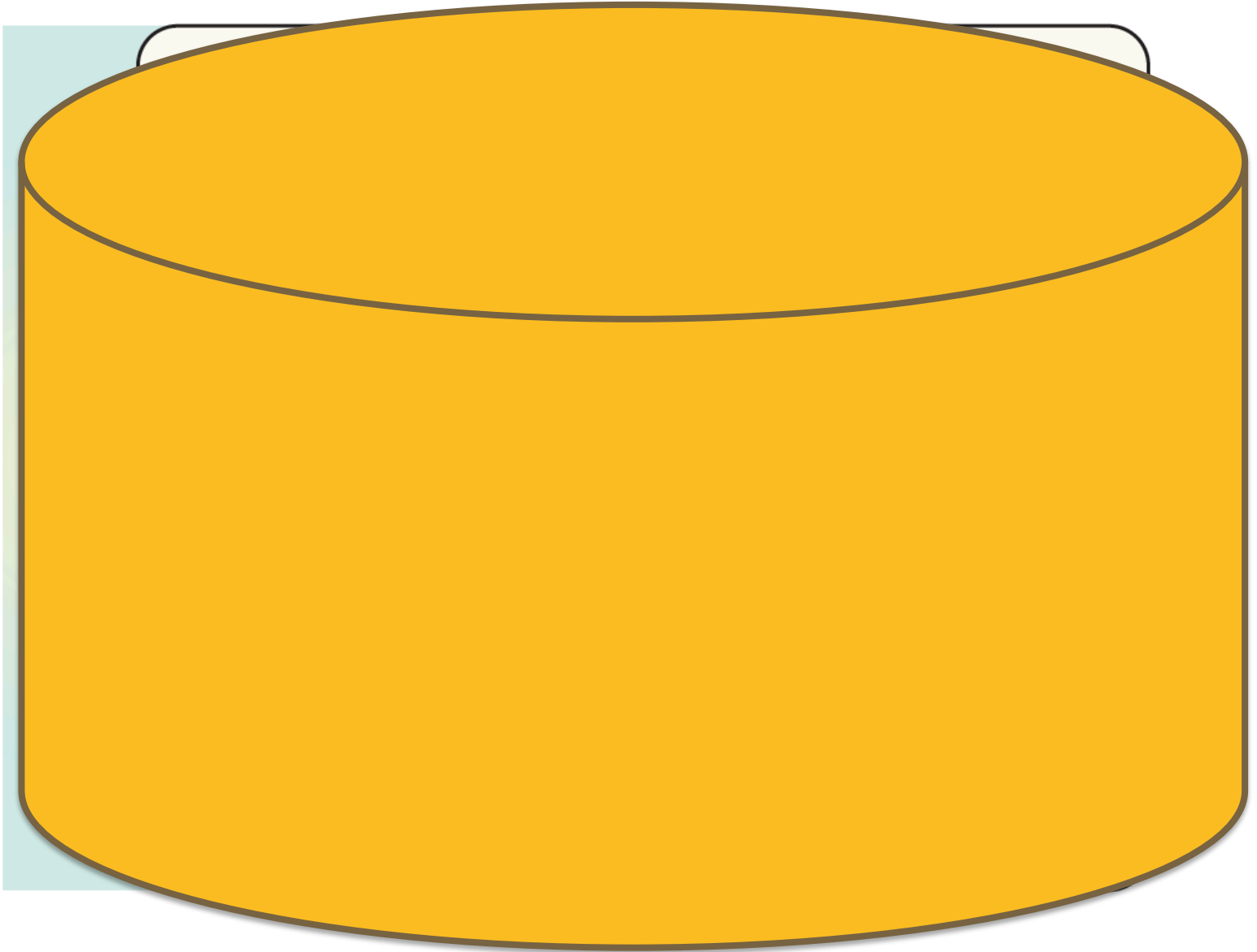
Reflect on CR Instructional Routine



What stands out to you about the Connecting Representations instructional routine?

What questions do you have?

Connecting Representations Container



MP7 in Connecting Representations



- MP7 Goal
 - To learn to “think like a mathematician” by connecting two things that look nothing alike at all, but represent the same underlying structure.
- Task selection that invites structural thinking
- Questions that orient attention to structure
 - What are the pieces of the visual and how do they connect to the rule?
 - How can you make sense of those pieces?
 - What do those operations imply?
- Meta-cognitive reflection focused on structure
 - I noticed.....so, I looked for....
 - _____ reminded me of _____



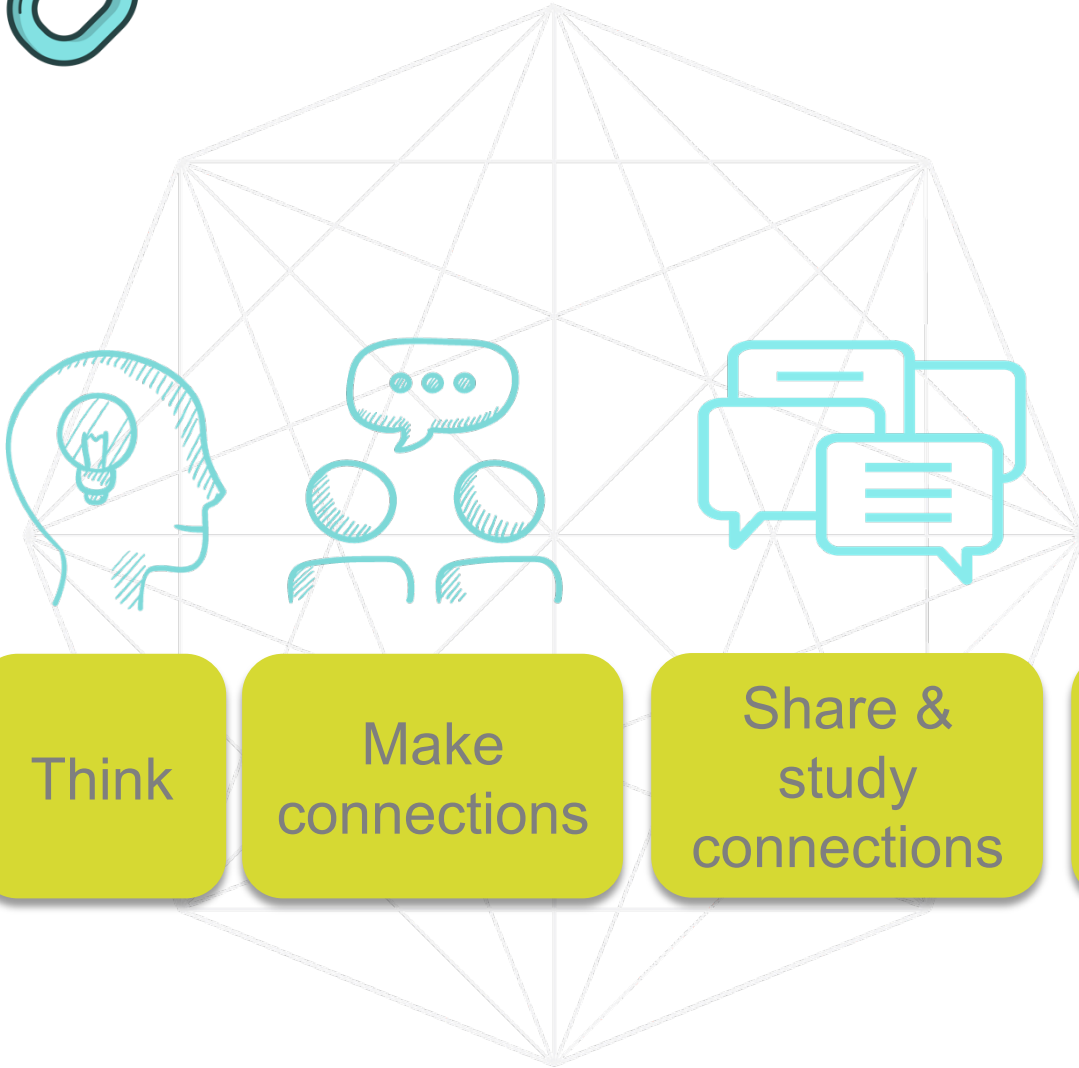
Connecting Representations

WHAT: Match words (verbal descriptions) to expressions by **chunking**, **changing** the form, and **connecting** to math you know

WHY: To “think like mathematicians”, to use mathematical *structure* to match two different representations.



Connecting Representations



Think

Make
connections

Share &
study
connections



Create
representation



Reflect
on
learning

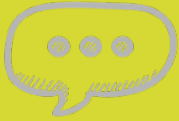


Think



Ask yourself...

- What chunk of the *verbal description* will help me connect to a part of the *expression*?
- What about the *expression* will help me connect to the verbal description?

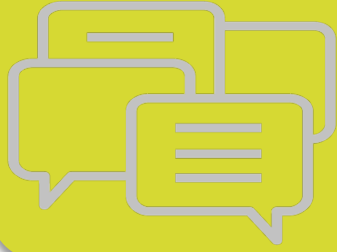


Make Connections

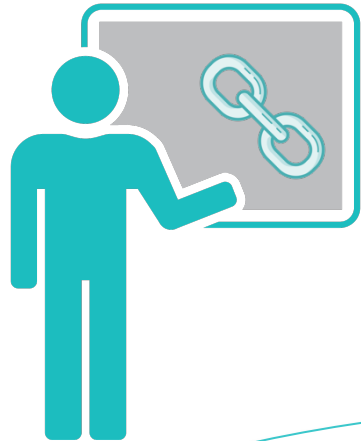


“I saw... so I connected...”

“... connects to ... because...”



Share & Study Connections



We noticed... so we ...
We knew... so we...

They noticed... so they ...
They knew... so they...



Create a Representation

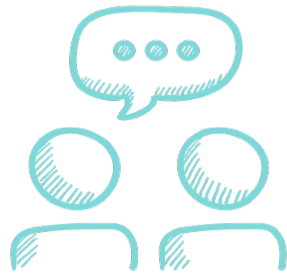


THINK

Ask yourself...

- “What do you notice about this *expression*?”
- “How can you chunk this *expression* into pieces you can describe?”

Create a Representation



Pair

- Share your interpretations of the *expression*.
- Together write a matching *verbal description*.

Create a Representation



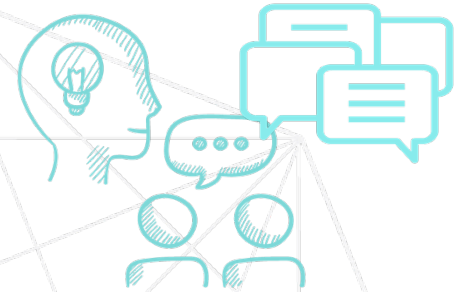
Share

They noticed... so they...

When they saw...it made them think of... so they...



Meta-Reflection

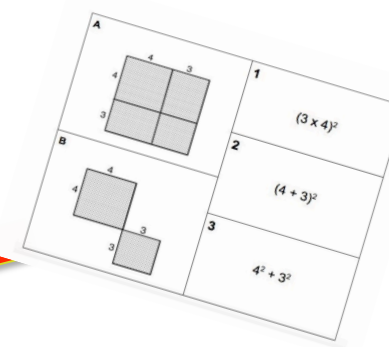
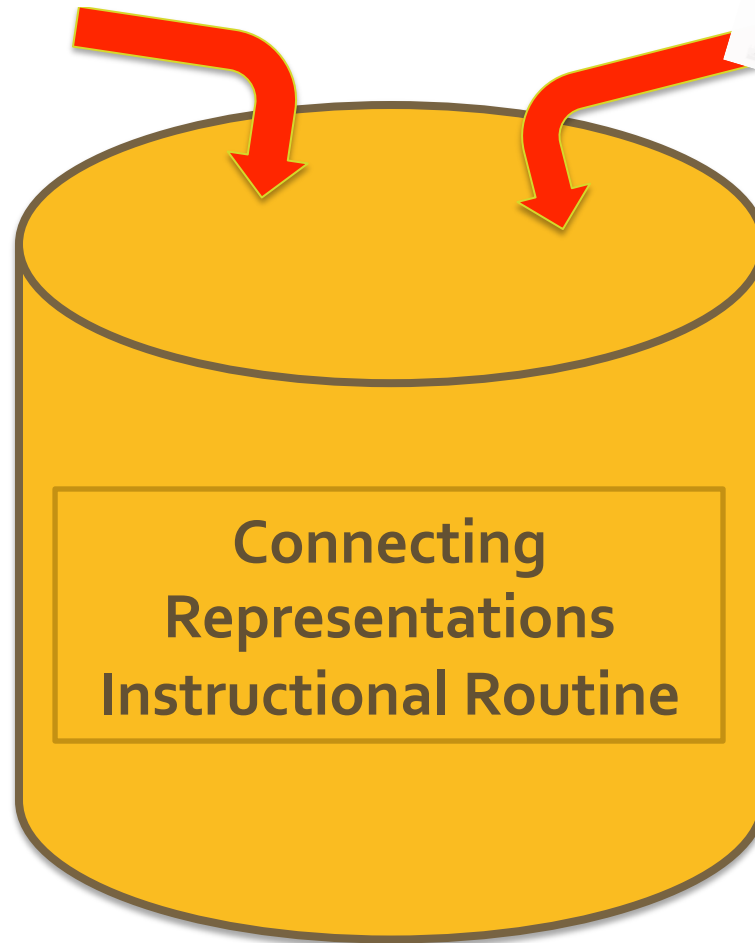


- A. When interpreting an expression, I learned to pay attention to...
- B. When connecting representations, I learned to ask myself...
- C. A new mathematical connection I made is...

$2(x^2y^2)^3$ The product of x -squared and y all raised to the third power, times 2

$(2x^2y^2)^3$ The product of $2x$ -squared and y all raised to the third power

$(2x^2)^3y$ The product of 2 and x -squared all raised to the third power, times y



Connecting Representations Container

Thinking Goal: Reason Structurally

1

Launch the Connecting Representations Routine:
Introduce thinking goal, review routine's steps

2

Interpret and Connect Representations

Individual Think Time


Pairs



Share: Discuss and Annotate



3

Create Representations

Individual Think Time


Pairs



4

Discuss Representations

Individual Think Time


Pairs



Share: Discuss and Annotate



5

Reflect on Your Thinking

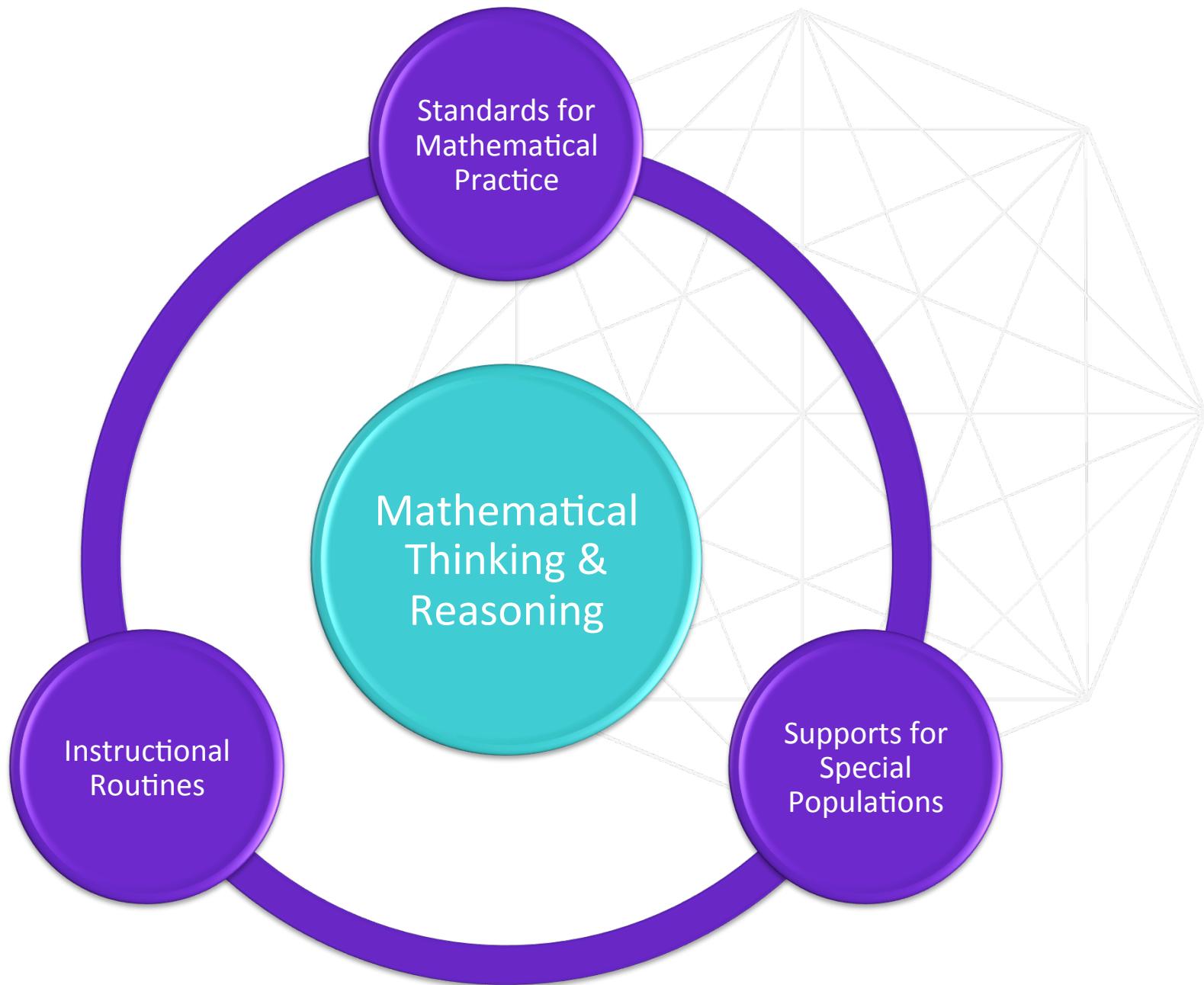
Individual Write Time


Pairs



Share and Record





Standards for
Mathematical
Practice

Mathematical
Thinking &
Reasoning

Instructional
Routines

Supports for
Special
Populations

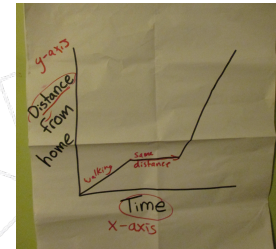
Reflect on CR Instructional Routine



How does/can the Connecting Representations instructional routine provide access and support for SWLD to develop the math practices?

Essential Strategies

Annotation



Next time I will.... before I calculate because

Paying attention to... is helpful because...

Sentence Starters/Frames

Four Rs: Repeat, Rephrase, Reword, Record



Ask Yourself Questions

Baked-In Supports for Students with Learning Disabilities within Connecting Representations



- Provide **multiple passes** at articulating the underlying structure between representations using the **Four Rs**.
- Reference **sentence frames and starters** to prompt students to articulate observations that sparked the structural thinking and that can be applied again in other math problems.
- Use **annotation** to make structural connections explicit for students and to provide visual residue of the mathematical discussions.
- Choose **representations** that support students' learning strengths.
- Support students' participation in full-group discussions by defining **partner roles**.

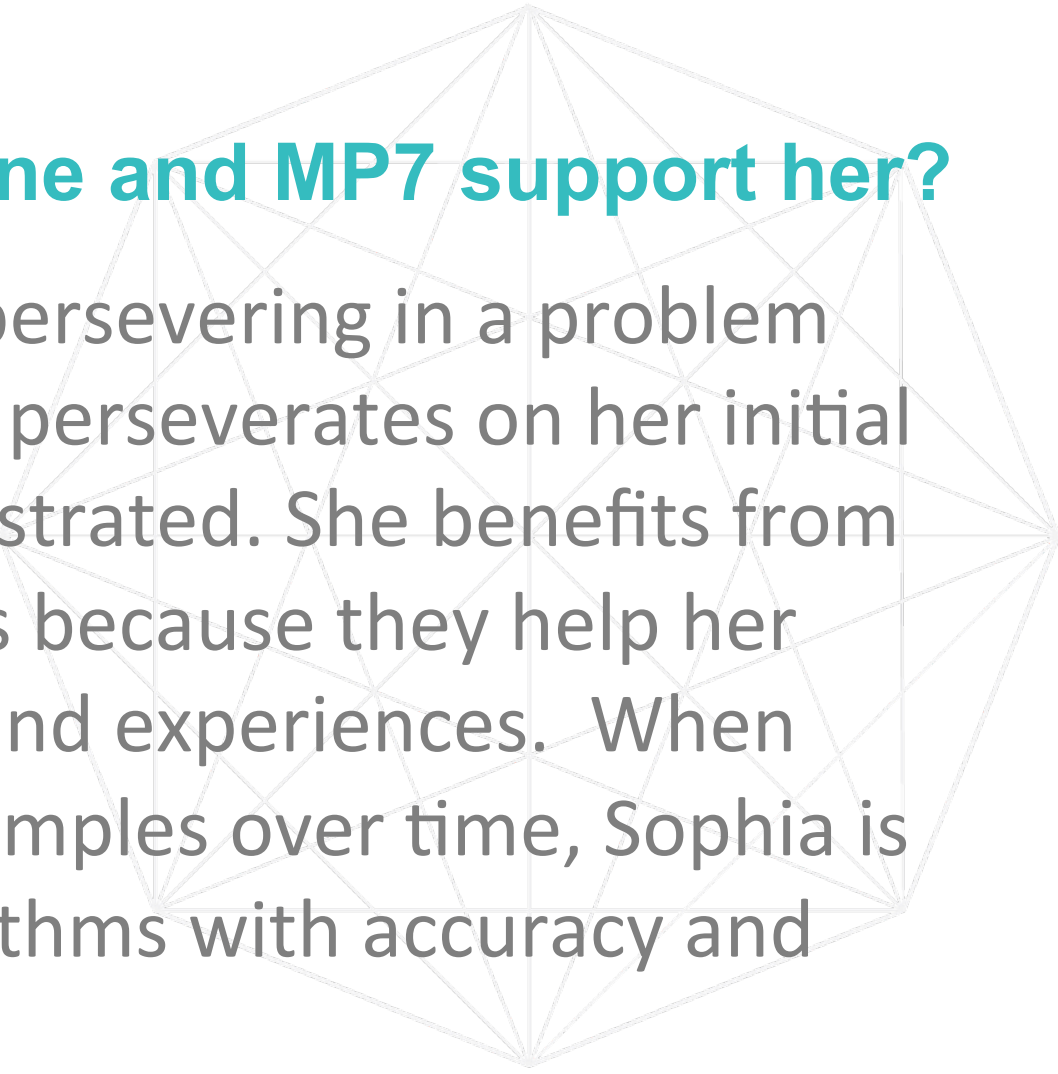
Baked-In Supports for ELLs within Connecting Representations



- Use **sentence starters and sentence frames** to develop structural language (e.g. chunk, change, connect) and help students communicate structural elements of representations.
- Make use of the **Four Rs** to provide multiple opportunities to develop and refine academic language crucial for describing structural connections among representations.
- Ensure that **gestures and annotation** support the structural ideas and language and thinking that is being communicated verbally.

Consider Sophia: How could the routine and MP7 support her?

Sophia has difficulty persevering in a problem situation as she often perseverates on her initial idea and becomes frustrated. She benefits from visual representations because they help her remember concepts and experiences. When provided multiple examples over time, Sophia is able to execute algorithms with accuracy and efficiency.



The Power of Routines

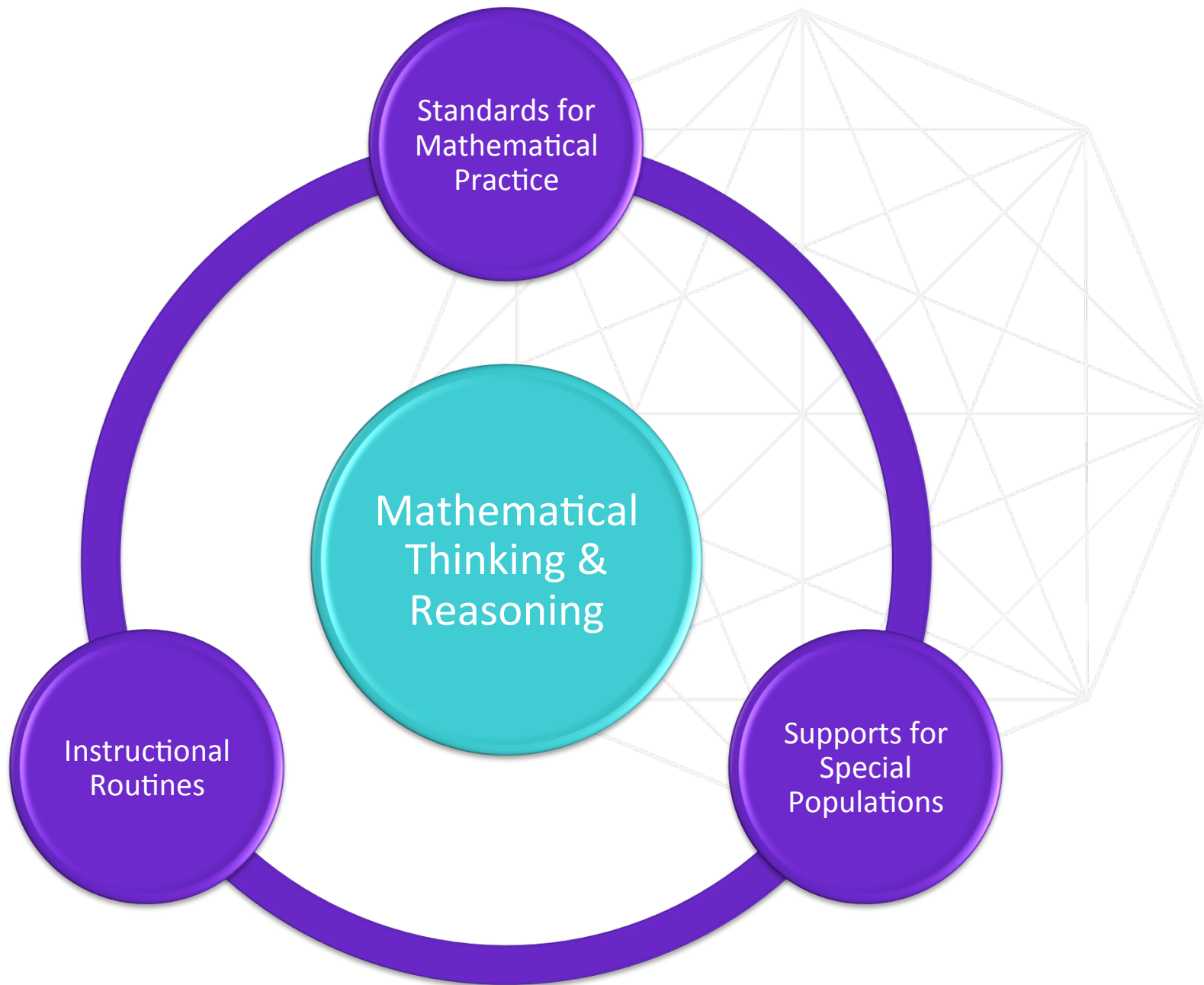


Instructional routines...

- support students.
- are collaborative.
- free up brain space for the hard work.
- serve as vehicles for the Five Practices.
- save time.
- develop math practices over time.
- Wash, rinse, repeat.

....AND....

- Develop equitable practice in a classroom, school, district.



Standards for
Mathematical
Practice

Mathematical
Thinking &
Reasoning

Instructional
Routines

Supports for
Special
Populations

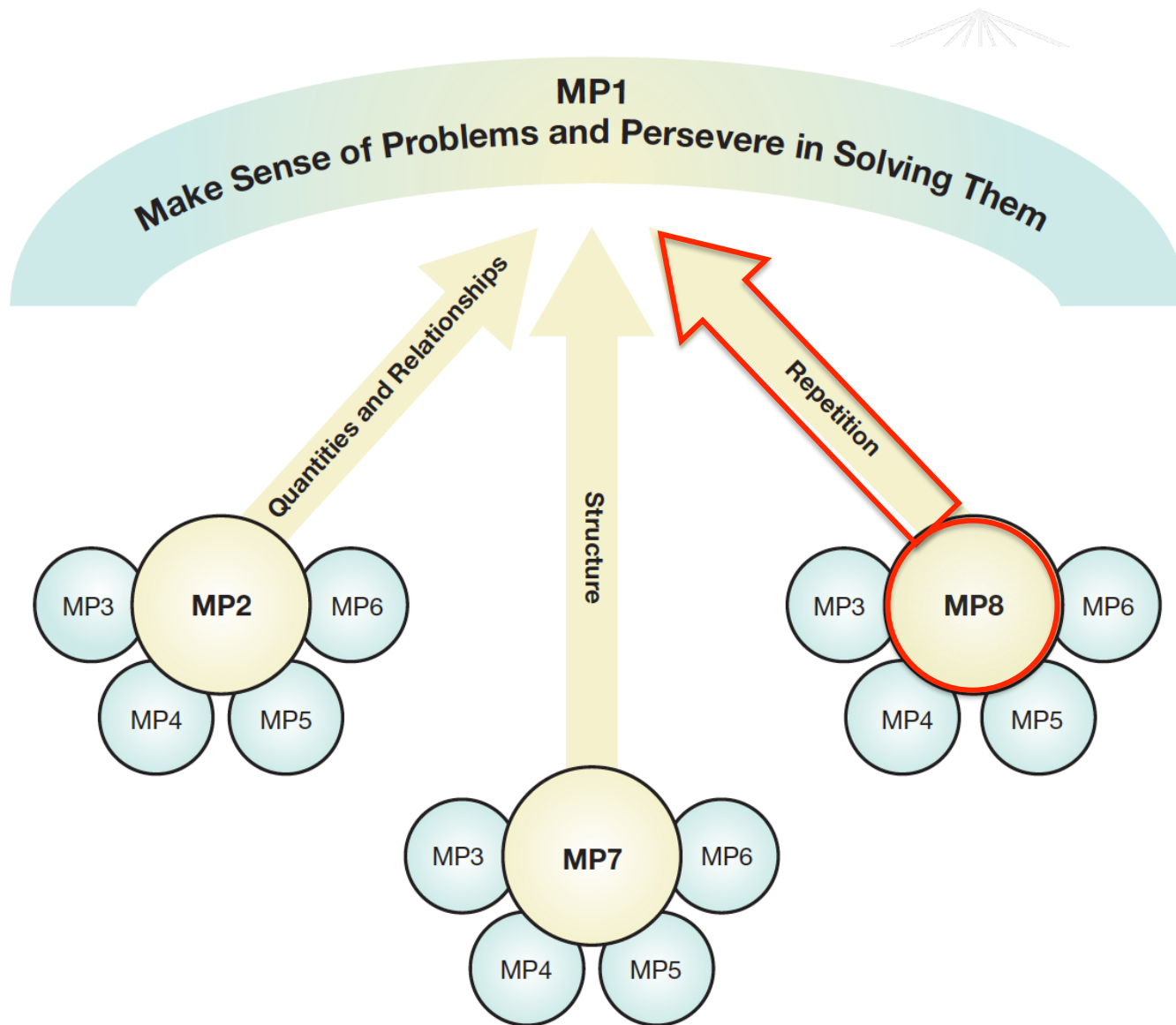
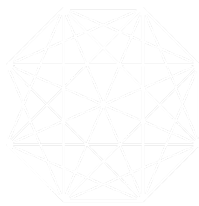


Figure 1.1 Diagram that shows the relationship of the practices to each other



Recognizing Repetition

An Instructional Routine to Develop
Repeated Reasoning



FOSTERING
MATH
PRACTICES

Repeated Reasoning Deep Dive Goal



Learn how to teach students to reason through repetition

- Understand how repetition in *process* is different from number patterns
- Know the different types of mathematical “processes” to mine for repetition
- Understand the flow and purpose of the *Repeated Reasoning* Instructional Routine

Recognizing Repetition Deep Dive



1. A few words about repeated reasoning
2. Experience the *Recognizing Repetition* Instructional Routine x2
3. Unpack the *Recognizing Repetition* Instructional Routine
4. Consider who this routine supports and how it supports them

Repeated Reasoning (MP8)

Attend to...

Repetition in
Processes

Counting

Calculating

Constructing

Ask yourself...

- Do I keep doing the same thing over and over again?
- What about the process is repeating?
- How can I generalize the repetition?
- Have I included every step?

Repeated Reasoning (MP8)

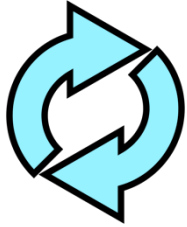
Actions You Take...

- Count in an organized way
- Draw or build several figures
- Try several numbers and observe the process
- Record and track calculations
- Generalize the repetition
- Simultaneously maintain oversight of the process while attending to details
- Monitor and evaluate reasonableness of intermediate results

Decompressing Repeated Reasoning

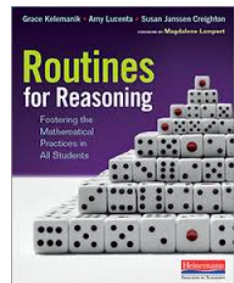


- Pay attention to the process
- Sense the regularity
- “Shortcut” the process
- Connect the process to an “input” value
- Generalize the process to a rule



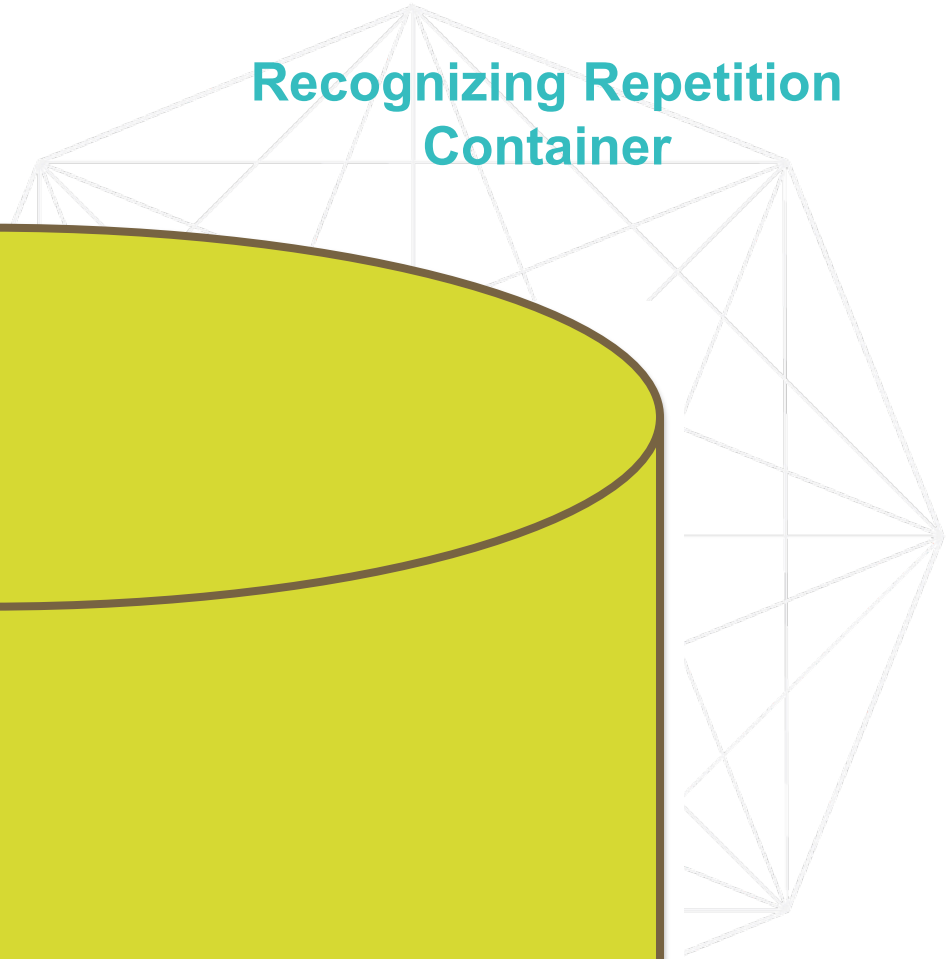
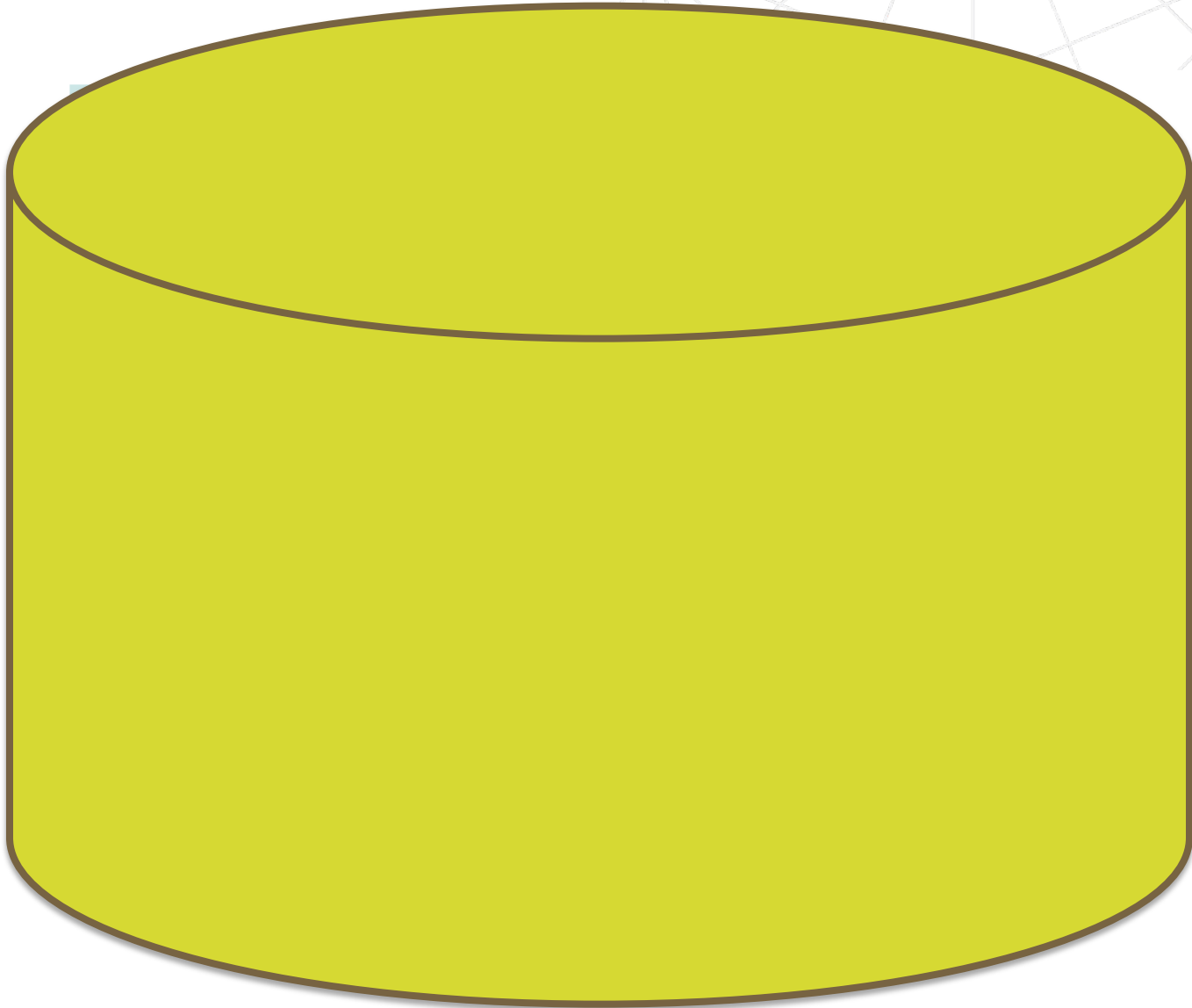
Recognizing Repetition

An Instructional Routine to develop
the repeated reasoning avenue of
thinking



Routines for Reasoning
Kelemanik, Lucenta & Creighton

Recognizing Repetition Container



Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice
Repetition

Individual
Think Time



Pairs



Share:
Discuss and Annotate



3

Generalize
Repetition

Individual
Think Time



Pairs



4

Discuss
Generalization

Individual
Think Time



Pairs



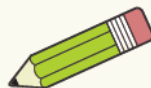
Share:
Discuss and Annotate



5

Reflect on
Your Thinking

Individual
Write Time

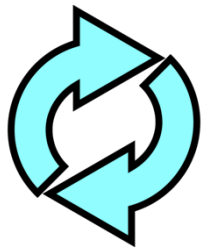


Pairs



Share
and Record

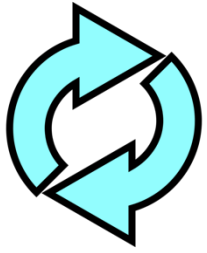




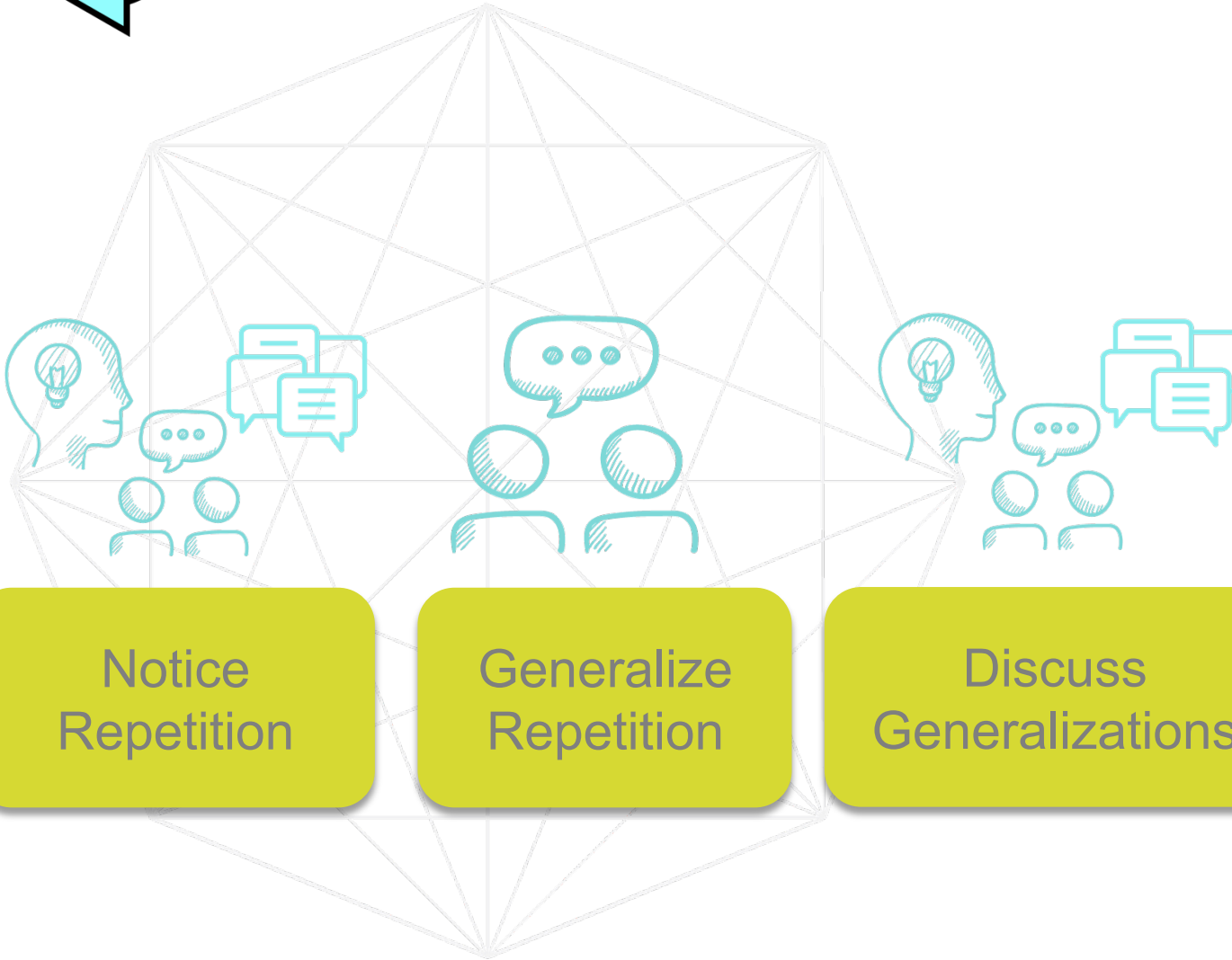
Recognizing Repetition

WHAT: Sense the repetition in the way you draw/build and generalize the repetition.

WHY: To “think like mathematicians”, look for regularity in your counting, calculating, and *constructing* processes.



Recognizing Repetition



Notice
Repetition

Generalize
Repetition

Discuss
Generalizations

Reflect on
learning

Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice Repetition

Individual Think Time



Pairs



Share: Discuss and Annotate



3

Generalize Repetition

Individual Think Time



Pairs



4

Discuss Generalization

Individual Think Time



Pairs



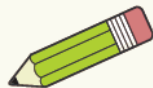
Share: Discuss and Annotate



5

Reflect on Your Thinking

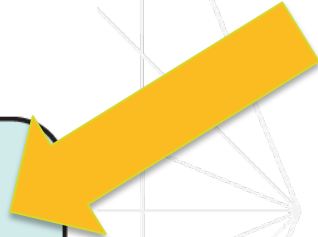
Individual Write Time



Pairs



Share and Record





Notice Repetition

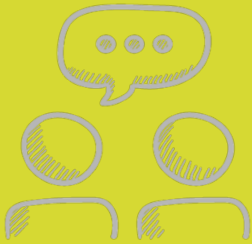
Draw or Build



Ask yourself...

- Am I drawing/building the same way each time?





Notice Repetition

Show Drawing/Building



Ask yourself...

- Are they drawing/building the same way each time?



LOOK for repetition

LISTEN for repetition





Notice Repetition

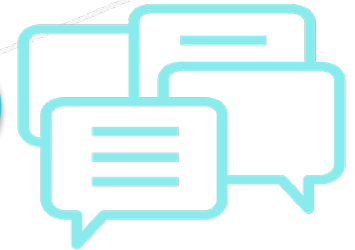
Share Drawing/Building



First...Next...Then...Finally...

Every time...

Every time they ...



Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice Repetition

Individual Think Time



Pairs



Share: Discuss and Annotate



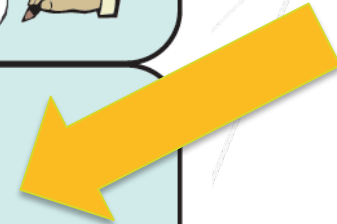
3

Generalize Repetition

Individual Think Time



Pairs



4

Discuss Generalization

Individual Think Time



Pairs



Share: Discuss and Annotate



5

Reflect on Your Thinking

Individual Write Time



Pairs



Share and Record



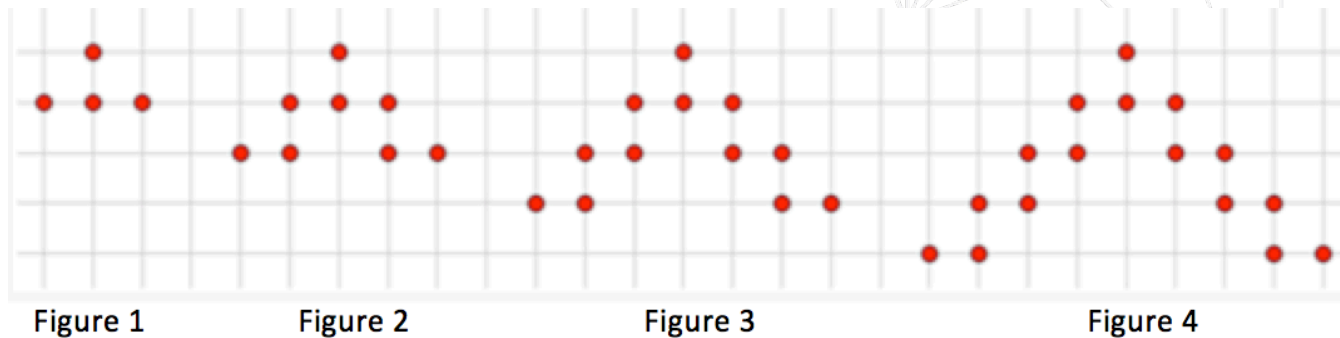


Generalize the Repetition



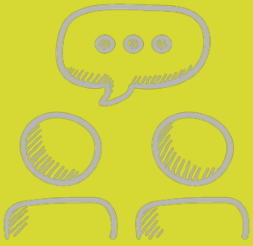
Ask yourself...

- How can I use the **repetition in my drawing/building process** to find the number of circles in figure 10?



?

Figure 10



Generalize the Repetition



- First...Next...Then...Finally...

1. Explain how you found the number of circles in figure 10.
2. Together, make a rule to find the number of circles in figure N.

Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice Repetition

Individual Think Time



Pairs



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Generalize Repetition

Individual Think Time



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Discuss Generalization

Individual Think Time



Pairs



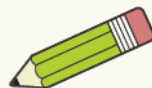
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Reflect on Your Thinking

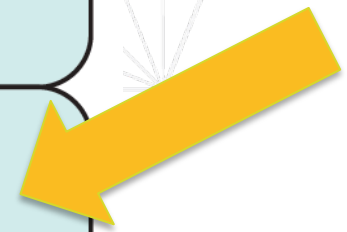
Individual Write Time

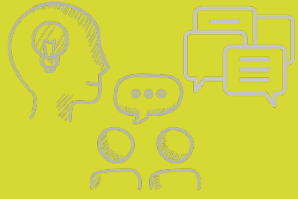


Pairs



Share
and Record





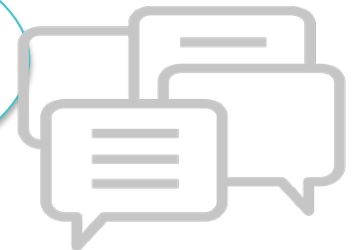
Discuss Generalizations



Ask yourself...

- What is the **repetition** they are generalizing?

The repetition they
generalized is...



Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice Repetition

Individual Think Time



Pairs



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Generalize Repetition

Individual Think Time



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Discuss Generalization

Individual Think Time



Pairs



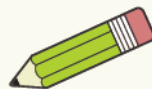
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Reflect on Your Thinking

Individual Write Time



Pairs

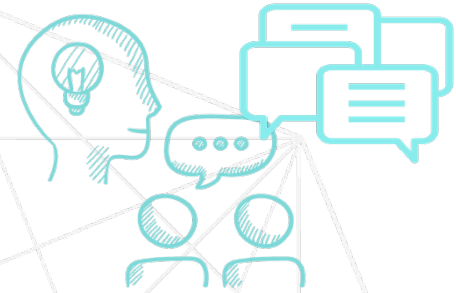


Share
and Record





Meta-Reflection



- A. When looking for repetition, I learned to pay attention to...
- B. When generalizing repetition, I learned to...

Recognizing Repetition

Thinking Goal: Reason with Repetition

1

Launch the Recognizing Repetition Routine:
Introduce thinking goal, review routine's steps

2

Notice
Repetition

Individual
Think Time



Pairs



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Generalize
Repetition

Individual
Think Time



Pairs



4

Discuss
Generalization

Individual
Think Time



Pairs



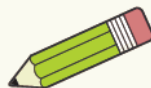
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5

Reflect on
Your Thinking

Individual
Write Time

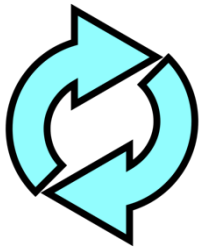


Pairs



Share
and Record

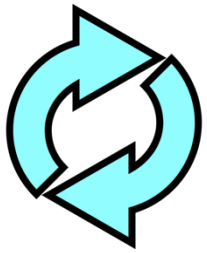




Recognizing Repetition

WHAT: Look for regularity in your *calculating* process and generalize that repetition.

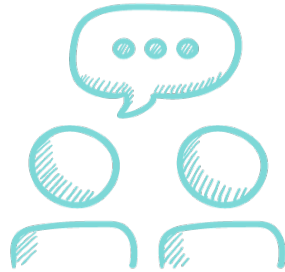
WHY: To “think like mathematicians”, look for regularity in your counting, *calculating*, and constructing processes.



Recognizing Repetition



Notice
Repetition



Generalize
Repetition



Discuss
Generalizations



Reflect on
learning



Recognizing Repetition

Thinking Goal: Reason with Repetition

1

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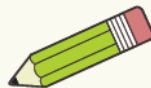
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Reflect on Your Thinking

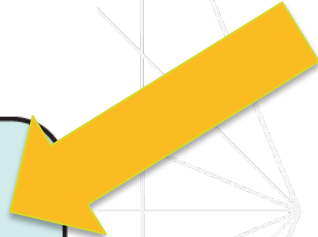
Individual Write Time



Pairs



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and Record





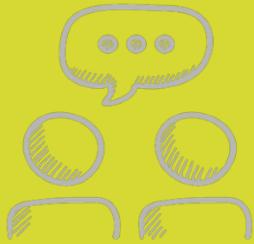
Notice Repetition In Calculations



Ask yourself...

- Am I calculating the same way each time?

Mr. Munroe was buying furniture for the McKay School. He spent \$7,600 on chairs and also bought some tables for \$50 each. Find out the total amount he would spend on furniture if he bought 1, 2, 3, and 10 tables.



Notice Repetition

Show Calculation Process



Ask yourself...

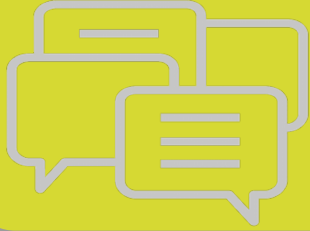
- Are they calculating the same way each time?



LOOK for repetition

LISTEN for repetition





Notice Repetition In Calculations



First...Next...Then...Finally...
Every time...

Every time they ...



Recognizing Repetition

Thinking Goal: Reason with Repetition

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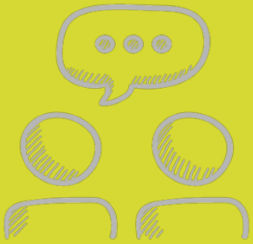
Generalize the Repetition



Ask yourself...

- How can I use the **regularity in my calculations** to make a rule for any number of tables?

Mr. Munroe was buying furniture for the McKay School. He spent \$7,600 on chairs and also bought some tables for \$50 each. **Find a rule for determining the total amount Mr. Munroe would spend given any number of tables.**



Generalize the Repetition



- The repetition in my calculation process I am trying to generalize is...

- Every time I... so my t generalization is...

Recognizing Repetition

Thinking Goal: Reason with Repetition

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Launch the Recognizing Repetition Routine:
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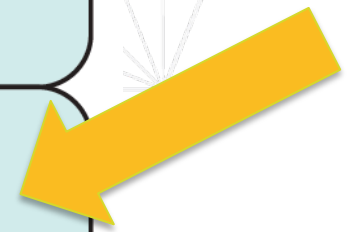
Individual Write Time

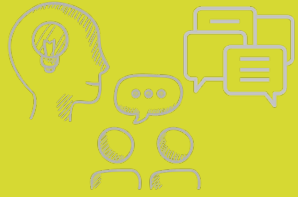


Pairs



Share
and Record





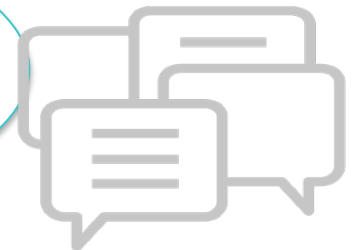
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Ask yourself...

- What is the **repetition** they are generalizing?

The repetition they
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Recognizing Repetition

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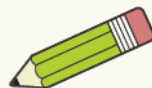
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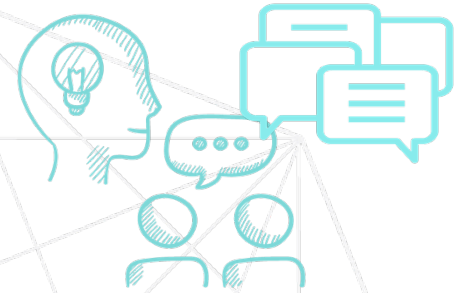


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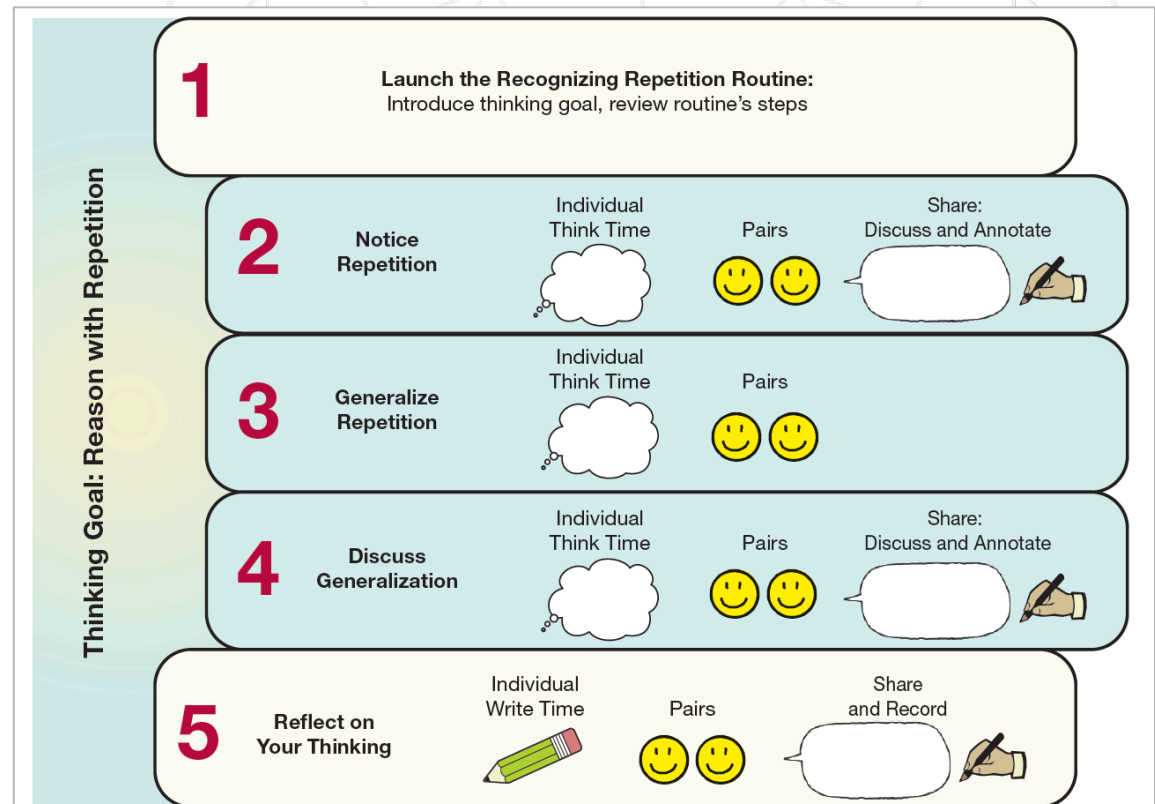
Meta-Reflection



- A. When looking for repetition, I learned to pay attention to...
- B. When generalizing repetition, I learned to...

What is it about the *Recognizing Repetition* Instructional Routine that...

- Provides access and support to English learners?
- Provides access and support to students with learning disabilities?



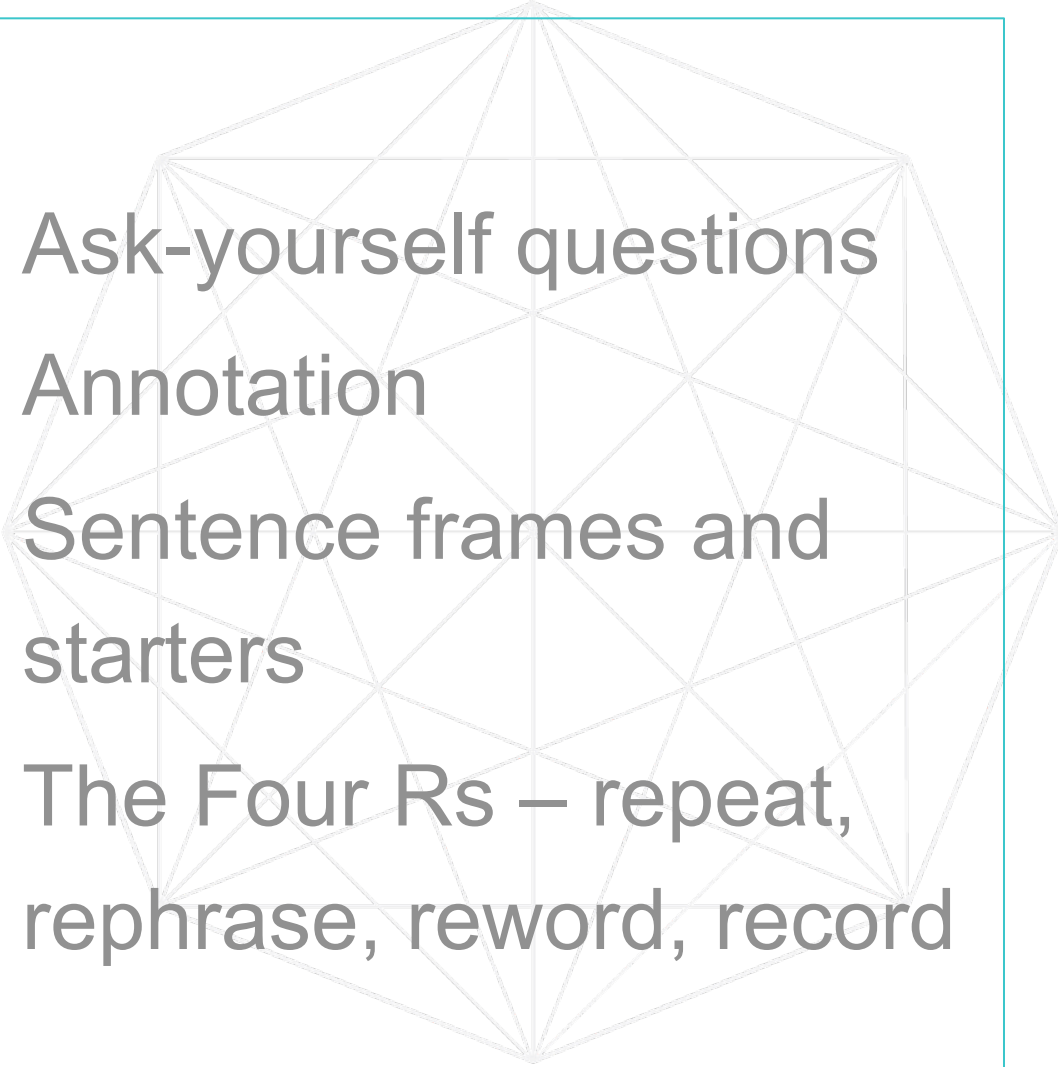
How does Recognizing Repetition Support Special Populations?

- It's predictable!
- Combats learned helplessness because it invites multiple sensing modalities and habitualizes “ask yourself” questions
- Promotes a view of generalizing that is sensible, not magic
- Places a premium on processing time and modalities
- Provides opportunities to develop and practice language



4 Essential Instructional Strategies

Keeping the focus on the mathematical thinking while providing access for a wide range of learners

- 
- Ask-yourself questions
 - Annotation
 - Sentence frames and starters
 - The Four Rs – repeat, rephrase, reword, record

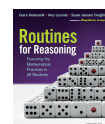
Repeated Reasoning “Look Fors”

Your students know that:

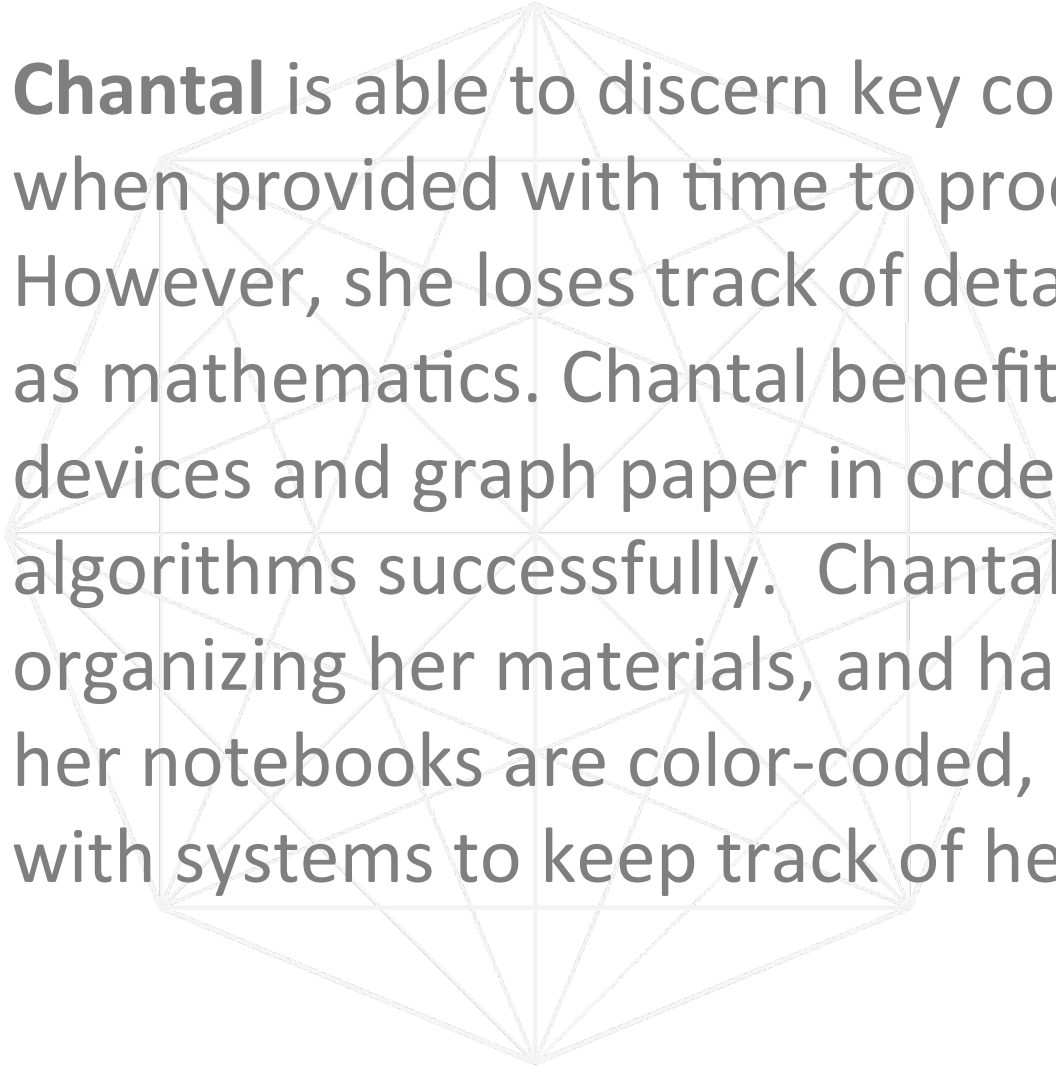
- Repetition in their counting, calculating, or building can be seen, heard, and felt.
- They can use regularities in their process to identify a generalized statement about the mathematics.
- A key to generalizing repetition is to connect an aspect of the repetition in their process to a quantity in the problem (such as the term of the series, the tower number, or one of the variables in the problem).
- If there is no repetition in a problem situation, they can sometimes create repetition by trying numbers and tracking their calculation process.

Your students *regularly* take the following actions:

- Pay attention to how they count, calculate, and construct.
- Record their counting, calculating, and constructing processes and look for repetition in them.
- Show examples of using their senses to highlight repeated reasoning; for example, they might recite repetitive steps they’re taking, move manipulatives in a rhythmic way through a process, draw a diagram that shows some repeating process, physically act out a process to notice what repeats, etc.



Consider Chantal: How could the routine and MP8 support her?



Chantal is able to discern key concepts and ideas when provided with time to process the ideas. However, she loses track of details in reading as well as mathematics. Chantal benefits from mnemonic devices and graph paper in order to implement algorithms successfully. Chantal has difficulty organizing her materials, and has found success when her notebooks are color-coded, and she is provided with systems to keep track of her belongings.

INSPIRED BY A PUBLIC SCHOOL STUDENT WITH DISABILITIES



COULD YOU PLEASE SHOVEL THE RAMP?

ALL THESE OTHER KIDS ARE WAITING TO USE THE STAIRS. WHEN I GET THROUGH SHOVELING THEM OFF, THEN I WILL CLEAR THE RAMP FOR YOU.

BUT IF YOU SHOVEL THE RAMP, WE CAN ALL GET IN!

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Next Steps:

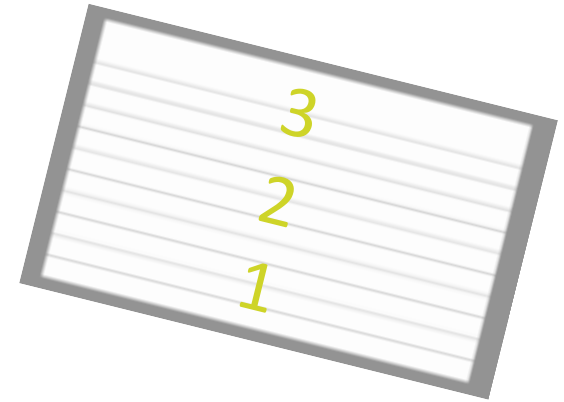
Select a routine to plan for during tomorrow's session

- **Three Reads**
- **Capturing Quantities**
- **Connecting Representations**
- **Recognizing Repetition**

Complete Google Form via website link (Related Resources Tab - Presentations)

Read the corresponding chapter in the book

Feedback

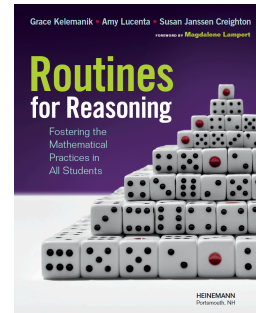


3 Things I learned

2 Questions I have

1 Thing I want you to know

Homework



- Read the chapter in Routines for Reasoning on the routine you selected to try
 - Chapter 3 – Capturing Quantities (MP2)
 - Chapter 4 – Connecting Representations (MP7)
 - Chapter 5 – Recognizing Repetition (MP8)
 - Chapter 6 – Three Reads (MP1)