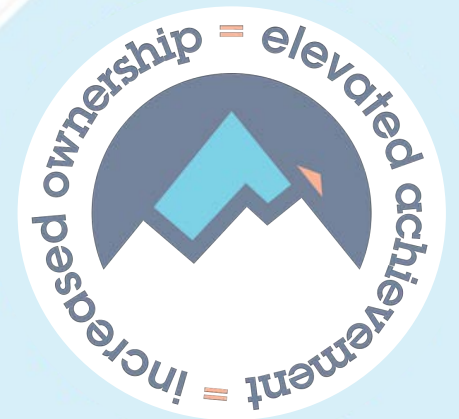


Elevated Achievement Group presents...

Solving the Mathematical Practices Puzzle: How to Develop Students' Skills and Metacognition in Math

June 9, 2021



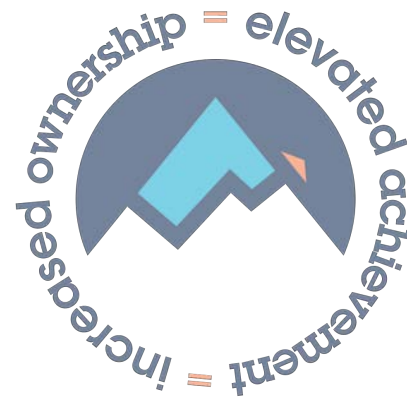
Presenter

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elevate **ACHIEVEMENT** by . . .

Developing Students' Skills and Metacognition in Math

Agenda

LEARNING CONTEXT	For our students to learn mathematical content at the depth expected, students need instruction that will develop the disposition and ways of thinking that are the foundation of math learning.	
LEARNING OUTCOME	Participants will reflect on what supports teachers will need to help students develop metacognition in mathematics.	
LEARNING PROCESS	CONTENT	STRATEGIES
	<ul style="list-style-type: none"> • Define the two types of mathematics standards • Define practices for metacognition • Analyze the learning progression of a mathematical practice • Develop questions to foster metacognition in mathematics 	<ul style="list-style-type: none"> • Structured Communication • Academic Vocabulary Development • Close Reading • Gradual Release of Responsibility • Routines • Reflection and Metacognition
LEARNING DEMONSTRATION	Participants will determine next steps for continued support to promote metacognition requiring students to examine, externalize, and apply their thinking.	
LEARNING APPLICATION	Participants will implement next steps for continued support to promote metacognition in mathematics.	

The Math Wars

“The new standards grew out of a long and heated debate about mathematics learning...known as the ‘math wars,’ pitting conceptual understanding and sense-making against procedures, rules, and memorization. The new math standards grew out of the decades-long attempts to acknowledge that both were important aspects of the math curriculum. By incorporating both..., they brought together both sides of the math wars, building on ‘the best of previous state standards plus a large body of evidence from international comparisons and domestic reports and recommendations to define a sturdy staircase to college and career readiness.’ (National Governors Association, 2013)”

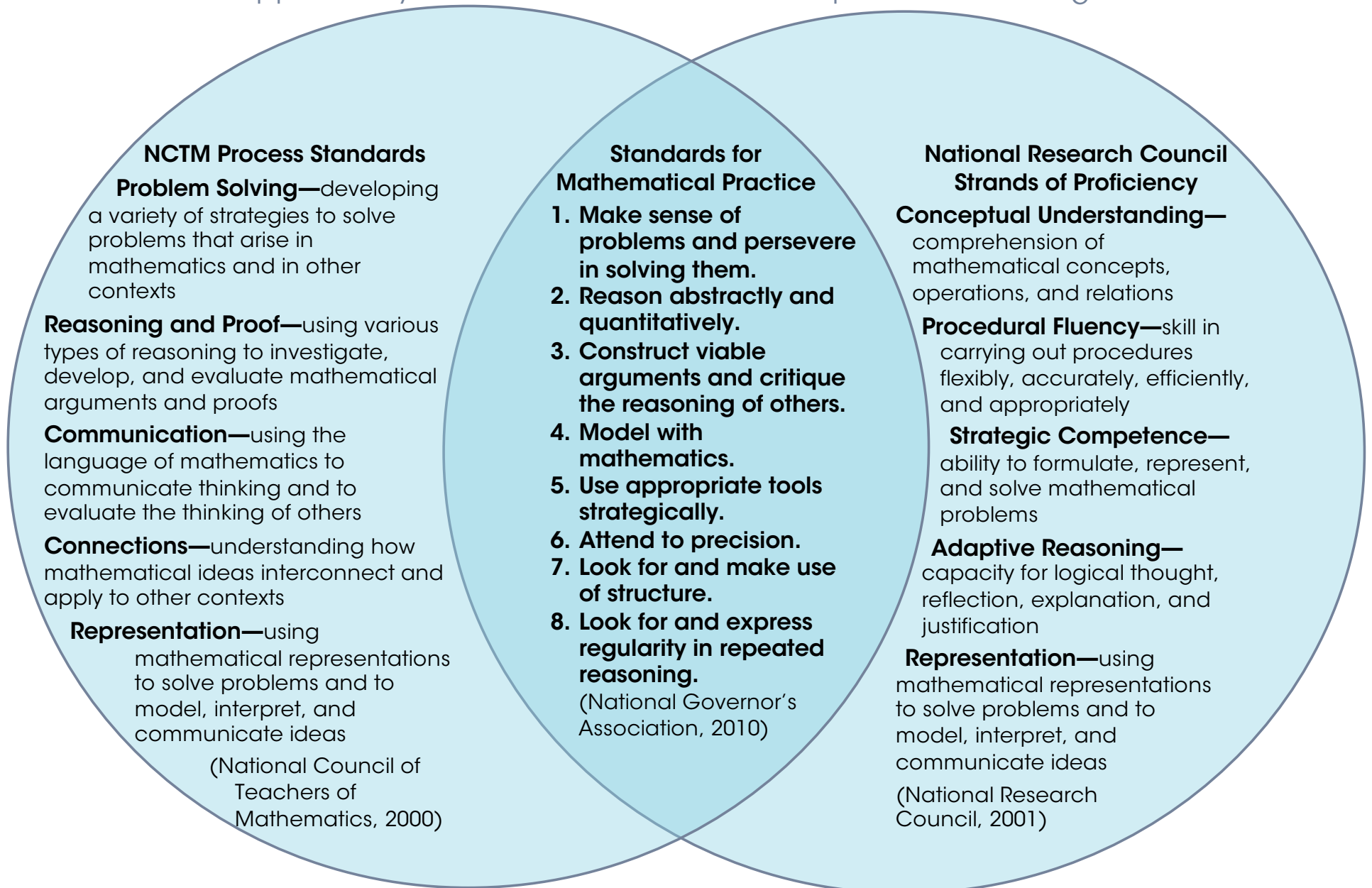
— *The Practices in Action, 2021*

Two Types of Standards

STANDARDS FOR MATHEMATICAL CONTENT	STANDARDS FOR MATHEMATICAL PRACTICE
<p>A list of things students should understand and be able to do by the end of each grade</p> <ul style="list-style-type: none">• Specific mathematical knowledge and skills that follow a step-by-step learning progression across grade levels and courses• K-8 organized by grade level; high school organized by conceptual theme• Familiar to most teachers• Easily and frequently test, and therefore the focus of the typical math curriculum	<p>A list of ways that proficient students engage with mathematics, including thinking skills and habits of mind</p> <ul style="list-style-type: none">• More general processes and proficiencies that evolve over time, influenced by cognitive development and the sophistication of the content• Standards are the same across all grade levels• Not as familiar to teachers• Not as easily or frequently tested, and therefore often neglected in the math curriculum

Defining the Practices for Metacognition

Students are supported by lessons that let them own the phases of learning.



Building Math Muscle Memory

“One hallmark of mathematical understanding is the ability to justify, in a way appropriate to the student’s mathematical maturity, why a particular mathematical statement is true or where a mathematical rule comes from. There is a world of difference between a student who can summon a mnemonic device to expand a product such as $(a + b)(x + y)$ and a student who can explain where the mnemonic comes from. The student who can explain the rule understands the mathematics and may have a better chance to succeed at a less familiar task such as expanding $(a + b)(x + y)$.”

— *National Governor’s Association, 2013*

Tools for Teaching the Practices

Tools for Teaching the Practices

The Standards

Practice
1

Make sense of problems and persevere in solving them.

Practice
2

Reason abstractly and quantitatively.

Practice
3

Construct viable arguments and critique the reasoning of others.

Practice
4

Model with mathematics.

Practice
5

Use appropriate tools strategically.

Practice
6

Attend to precision.

Practice
7

Look for and make use of structure.

Practice
8

Look for and express regularity in repeated reasoning.

Student Ownership Statements

Practice
1

I can determine what the problem is asking me to do and not give up until I've solved it.

Practice
2

I can make sense of quantities and use math symbols, numbers, or words to represent and solve problems.

Practice
3

I can justify my conclusions with evidence from my work, and I can listen to or read others' arguments and decide if they make sense.

Practice
4

I can use what I know about math symbols, words, pictures, tools, and diagrams to solve everyday problems.

Practice
5

I can determine which tools are the right ones to use when solving problems.

Practice
6

I can communicate precisely what I'm doing and explain my thinking using mathematical language.

Practice
7

I can determine overall structures and patterns to help me solve problems.

Practice
8

I can use what I already know about problem solving strategies, patterns, and other shortcuts to solve problems.

The Standard with Description and Examples

STANDARD FOR MATHEMATICAL PRACTICE 1:

Make sense of problems and persevere in solving them.

I can determine what the problem is asking me to do and not give up until I've solved it.

Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution. They analyze givens, constraints, relationships, and goals. They make conjectures about the form and meaning of the solution and plan a solution pathway rather than simply jumping into a solution attempt. They consider analogous problems, and try special cases and simpler forms of the original problem in order to gain insight into its solution. They monitor and evaluate their progress and change course if necessary. Older students might, depending on the context of the problem, transform algebraic expressions or change the viewing window on their graphing calculator to get the information they need. Mathematically proficient students can explain correspondences between equations, verbal descriptions, tables, and graphs or draw diagrams of important features and relationships, graph data, and search for regularity or trends. Younger students might rely on using concrete objects or pictures to help conceptualize and solve a problem. Mathematically proficient students check their answers to problems using a different method, and they continually ask themselves, "Does this make sense?" They can understand the approaches of others to solving complex problems and identify correspondences between different approaches.

In short, mathematically proficient students:

- Interpret and make meaning of the problem to find a starting point.
- Analyze what is given in order to explain to themselves the meaning of the problem.
- Plan a solution pathway instead of jumping to a solution.
- Monitor their own progress and change the approach if necessary.
- See relationships between various representations.
- Relate current situations to concepts or skills previously learned and connect mathematical ideas to one another.
- Continually ask themselves, "Does this make sense?"
- Can understand various approaches to solutions.

National Governors Association Center for Best Practices & Council of Chief State School Officers. 2010c

The Learning Progressions



Make sense of problems and persevere in solving them.

Learning Progression

PRE-K	In Pre-K, students involve themselves in solving problems by asking, "Can I solve this problem?"	PRE-K	In Pre-K, students <u>begin to build the understanding</u> that doing mathematics involves solving problems and discussing how they solved them. With prompting and support from adults, students explain the meaning of a problem and look for ways to solve it. Students use concrete objects to help them conceptualize and solve problems. They may check their thinking by asking, "Does this make sense?" or <u>they may try another strategy.</u>	the he solve most "Can I
KINDERGARTEN	In Kindergarten, students involve themselves in solving problems by asking, "Can I solve this problem?"	KINDERGARTEN	In Kindergarten, students <u>begin to build the understanding</u> that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Younger students may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" or <u>they may try another strategy.</u>	discuss the he solve most "Can I
FIRST GRADE	In first grade, students involve themselves in solving problems by asking, "Can I solve this problem?"	FIRST GRADE	In first grade, students <u>realize</u> that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Younger students may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" <u>They are willing to try other approaches.</u>	tion of a problem sk their ive the in a
SECOND GRADE	In second grade, students involve themselves in solving problems by asking, "Can I solve this problem?"	SECOND GRADE	In second grade, students <u>realize</u> that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. They may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" <u>They make conjectures about the solution and plan out a problem-solving approach.</u>	themselves on. They njectures pathway analogous problem their depending change ation between ns of egularity hods and erstand ty
THIRD GRADE	In third grade, students involve themselves in solving problems by asking, "Can I solve this problem?"			
FOURTH GRADE	In fourth grade, students involve themselves in solving problems by asking, "Can I solve this problem?"			
FIFTH GRADE	In fifth grade, students solve problems by applying their understanding of operations with whole numbers, decimals, and fractions including mixed numbers. They solve problems related to volume and measurement conversions. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?"			
SIXTH GRADE	In grade 6, students solve problems involving ratios and rates and discuss			

The Process and Reflection

Practice 1

Make sense of problems and persevere in solving them.

"I can determine what the problem is asking me to do and not give up until I've solved it."

Process

Process to make sense of problems

1. Read the problem out loud.
2. Identify and clarify each word that tells you what to do mathematically.
3. Explain the problem in your own words.
4. Explain how you will know you have solved the problem correctly.

Process to persevere in solving them

1. Make a plan for solving the problem.
2. Begin to solve the problem.
3. Each time you get stuck, identify where you got stuck.
4. Ask for help, as needed.
5. Keep working until you've solved the problem correctly.

Practice 1

Make sense of problems and persevere in solving them.

"I can determine what the problem is asking me to do and not give up until I've solved it."

Reflection

To what degree can you determine what the problem is asking you to do and not give up until you've solved it?

1	2	3	4	5
never		sometimes		always

- ▶ What does "make sense of problems" mean?
- ▶ What does "persevere in solving them" mean?
- ▶ How do you determine what the problem is asking you to do?
- ▶ How do you not give up until you've solved the problem?
- ▶ How does "making sense of problems and persevering in solving them" help you?

The Practices in Action

Practice 1

Make sense of problems and persevere in solving them.

Eighth Grade

The Practice in Action: When presented with a problem that asks students to define a function, eighth grade students utilizing this practice interpret the meaning of the problem in order to grasp the concept of a function and use it to describe quantitative relationships. They can also check their thinking by creating a table that represents the function and asking themselves "Does this make sense?"

How can you determine the total cost of renting a car from a rental company that charges \$45 a day? In addition, the rental company charges a one-time \$25 fee for the car navigation system (GPS).

TEACHER: What is the problem asking you to do?

STUDENT: *The problem is asking me to find the cost of renting a car.*

TEACHER: How could you go about solving the problem?

STUDENT: *I can solve this problem by first determining what information I am given is constant and what can change. Because the total cost of rental charges changes but the GPS fee is only paid once, I can write an equation as the total cost in dollars equals \$45 times the number of days, plus the one-time fee of \$25.*

TEACHER: What other ways you could approach the problem?

STUDENT: *I can plug in different values for the number of days and solve for the cost or I can create a table or graph that represents the same information.*

TEACHER: How did making sense of the problem and persevering in solving it help you?

STUDENT: *Making sense of problems and persevering in solving them helps me understand what the problem is really asking me to do. Then, I make a plan to solve it and work on it until it is finished.*

Questions to Foster Metacognition:

- What is the problem asking you to do?
- What is your plan for solving the problem?
- How would you explain what the problem is asking you to do in your own words?
- What information is given in the problem?
- What steps in the process are you most confident about?
- What are some other strategies you might try?
- Why is being able to interpret and make meaning of the problem important?
- How does analyzing the information given help you?
- Why is planning a solution pathway instead of jumping to a solution important?
- Why is monitoring your progress and changing the approach, if needed, important?
- Why is being able to see relationships between various representations important?
- Why is understanding various approaches to solutions important?
- Why is continually asking yourself, "Does this make sense?" important?
- How does making sense of problems and persevering in solving them help you?

Ownership Statements:

- Being able to interpret and make meaning of the problem is important because _____.
- Being able to look for starting points is important because _____.
- Analyzing what information is given helps me because _____.
- Planning a solution pathway instead of jumping to a solution is important because _____.
- Monitoring my progress and changing the approach, if needed, is important because _____.
- Being able to see relationships between various representations is important because _____.
- Understanding various approaches to solutions is important because _____.
- Continually asking myself, "Does this make sense?" is important because _____.
- Making sense of problems and persevering in solving them helps me _____.

Questions to Foster Metacognition

Practice
1

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Questions to Foster Metacognition:

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Information given help you?
Pathway instead of jumping to a solution important?
Progress and changing the approach, if needed,
Relationships between various representations important?
Various approaches to solutions important?
Continually asking yourself, "Does this make sense?" important?
Making sense of problems and persevering in solving them help you?

Make meaning of the problem is important

Information given is important because _____.

Information given helps me because _____.

Planning instead of jumping to a solution is important

Monitoring and changing the approach, if needed, is important

Seeing relationships between various representations is important

Understanding various approaches to solutions is important because _____.

Continually asking "Does this make sense?" is important because _____.

Making sense of problems and persevering in solving them helps me _____.

THE PRACTICES IN ACTION: EIGHTH GRADE

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Ownership Statements

Practice
1

Make sense of problems and persevere in solving them.

Eighth Grade

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Ownership Statements:

Being able to interpret and make meaning of the problem is important because _____.

Being able to look for starting points is important because _____.

Analyzing what information is given helps me because _____.

Planning a solution pathway instead of jumping to a solution is important because _____.

Monitoring my progress and changing the approach, if needed, is important because _____.

Being able to see relationships between various representations is important because _____.

Understanding various approaches to solutions is important because _____.

Continually asking myself, "Does this make sense?" is important because _____.

Making sense of problems and persevering in solving them helps me _____.

Questions to Foster Metacognition:

What is the problem asking you to do?

What is your plan for solving the problem?

How would you explain what the problem is asking you to do in your own words?

What information is given in the problem?

What steps in the process are you most confident about?

What are some other strategies you might try?

Is the meaning of the problem important?

Can others help you?

Is it important to think about the problem instead of jumping to a solution?

Is changing the approach, if needed, important?

Is understanding the relationship between various representations important?

Are there different approaches to solutions important?

Is continually asking "Does this make sense?" important?

Does persevering in solving them help you?

Is understanding the meaning of the problem important?

Can others help you?

Is it important to think about the problem instead of jumping to a solution?

Is changing the approach, if needed, important?

Is understanding the relationship between various representations important?

Are there different approaches to solutions important?

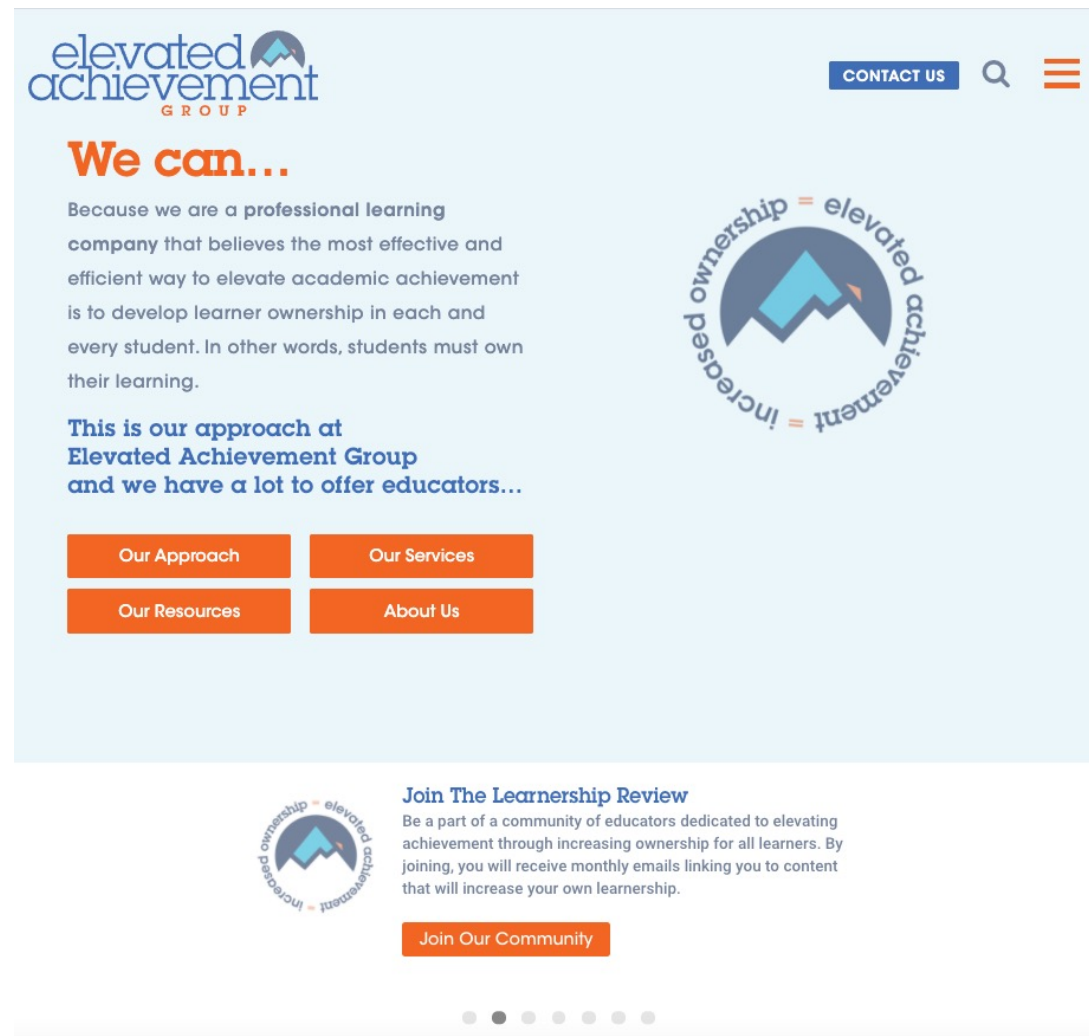
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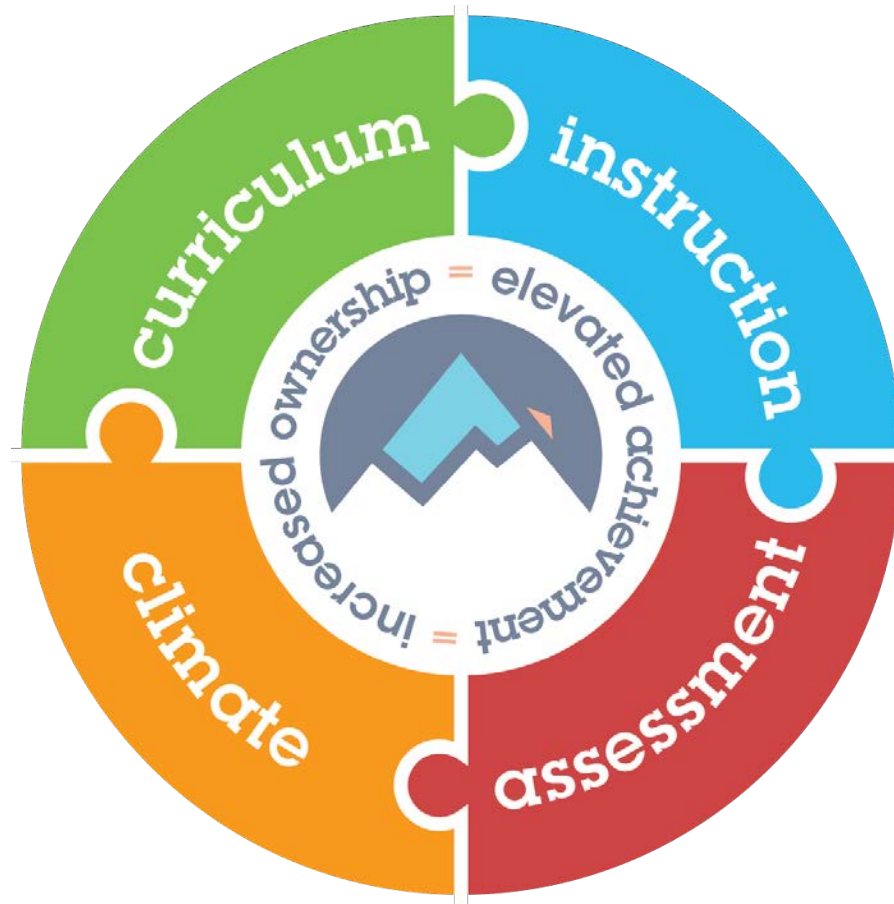
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The screenshot shows the homepage of the Elevated Achievement Group website. At the top left is the logo for 'elevated achievement GROUP' with a mountain icon. To the right are navigation links: 'CONTACT US', a search icon, and a hamburger menu icon. The main content area features the heading 'We can...' followed by a paragraph: 'Because we are a professional learning company that believes the most effective and efficient way to elevate academic achievement is to develop learner ownership in each and every student. In other words, students must own their learning.' Below this is another heading: 'This is our approach at Elevated Achievement Group and we have a lot to offer educators...'. There are four orange buttons: 'Our Approach', 'Our Services', 'Our Resources', and 'About Us'. On the right side of the main content area is a circular graphic with the text 'increased ownership = elevated achievement' around a mountain icon. At the bottom, there is a section titled 'Join The Learnership Review' with a paragraph: 'Be a part of a community of educators dedicated to elevating achievement through increasing ownership for all learners. By joining, you will receive monthly emails linking you to content that will increase your own learnership.' Below this is an orange button labeled 'Join Our Community'. At the very bottom, there are five small grey circles, with the second one from the left being filled in.



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