

# Setting the Stage for Productive Struggle

Grades K-5



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**Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle while they grapple with mathematical ideas and relationships.**

*Principles to Actions, NCTM, 2014*

## **Solve It**

How much money did Molly have?



Molly bought a cookie with 2 dimes and 1 nickel. How much did she pay for the cookie?

Molly bought a cookie for 25 cents. What coins could she have used?

Molly wanted to buy a snack at the school carnival. What are all of the possible ways Molly could have paid for a cookie with exact change?

Cookies – 25 cents

Cupcakes – 35 cents

Exact change only!

### **What is needed to navigate complex tasks?**

As students:

- Math skills
  - Computational
  - Conceptual understanding
  - Problem solving
- Perseverance
- Confidence
- Take risks
- Think like mathematicians

As teachers:

- Step back and let them think
- Relieve anxiety
  - Mistakes are part of the process
  - Not about speed
  - Often takes several tries
- Support when frustration rises
- Nurture perseverance
- Build skills

If we want students to achieve these goals, what experiences should they have in math class?



## **Setting the Stage for Productive Struggle**

- Selecting appropriate tasks
- Creating a classroom culture that accepts struggle, honors mistakes, rewards effort
- Orchestrating teacher moves that support students as they struggle, make mistakes, and rethink their efforts

## **What can we do?**

Pose tasks and step back

Support with questions during the task

Praise effort during the task

Debrief afterward about the task and the struggle

How did you do it?

How did you feel as you were doing it?

Did you get stuck? How did you get unstuck?

## Exploring Perseverance

What is perseverance?

What does it look like when students do not persevere?

### When do our students need perseverance?

- When tasks are lengthy
- When tasks have multiple parts
- When tasks feel confusing
- When they realize their path won't lead them to the solution
- When they begin to feel anxious
- When they realize their answer is incorrect

### Read and discuss *The Most Magnificent Thing* by Ashley Spires

- Retell the main events in the story.
- Why did she get mad? What happened when she got mad?
- What did she do when she got very frustrated? Was that a good idea? Why or why not?
- Some parts that she first thought were "not quite right" seemed "quite right" after her walk. Why do you think that was the case?
- When in the story did she show perseverance? Give examples.

### Getting Unstuck

Work in teams to:

- brainstorm ways you might get unstuck when you are having trouble with a problem.

Students then:

- create a poster with their ideas.
- do a galley walk or display/share ideas.
- copy a few ideas they like into their math journal.

Create a class anchor chart with students' ideas.

### Developing a Climate Conducive to Productive Struggle

#### Teacher Questioning

Then	Now
<ul style="list-style-type: none"><li>• What's the answer?</li></ul> <p>(1<sup>st</sup> hand up answers the question)</p> <p>A focus on process rather than answer helps to relieve anxiety.</p>	<ul style="list-style-type: none"><li>• <i>How did you get started? Were you able to find the solution with that approach?</i></li><li>• <i>Did you get stuck at any point?</i></li><li>• <i>How did you get unstuck?</i></li><li>• <i>How did you end up finding the solution?</i></li><li>• <i>How did you feel when you found the solution?</i></li><li>• <i>What would you do next time if you got stuck?</i></li></ul>

#### Teacher Comments

Then	Now
<ul style="list-style-type: none"><li>• Correct!</li><li>• You were the first one done!</li></ul> <p>Show students that you value perseverance and effort.</p>	<ul style="list-style-type: none"><li>• That wasn't what you were thinking in the beginning, was it? I like the way you <b>changed your mind after you noticed...</b></li><li>• You did a great job adjusting your approach! <b>When you realized you couldn't find the solution by adding the data, you recorded the data to look for patterns instead of giving up</b> and it led you to the answer!</li></ul>

#### Teacher Comments

Then	Now
<ul style="list-style-type: none"><li>• Do it silently by yourself.</li></ul> <p>Working in teams helps relieve anxiety. Collaboration promotes the sharing of strategies and builds trust.</p>	<ul style="list-style-type: none"><li>• <i>How did your team decide to do it?</i></li><li>• <i>What did you hear teammates say that helped you change your thinking?</i></li></ul>

### Mystery Number Puzzle

From *Math in Practice*

My number is a five-digit number. The digit in the ones place is half the digit in the ten thousands place.

When you add all the digits together, the sum is 23.

The digit in the ten thousands place is the area of a square with a side of 2 inches.

The digit in the thousands place is twice the digit in the ten thousands place.

The digit in the tens place is half the digit in the hundreds place.

The hundreds digit is the number of sides on a hexagon.

“Picture your brain forming new connections as you meet the challenge and learn. Keep on going.”

Carol Dweck

“Every time a student makes a mistake in math, they grow a synapse.” There.”

Jo Boaler

“Always give help when needed, always ask for help when you need it”

Jo Boaler

### Idea to Try:

Welcome students to your math class with erasers! Let them know that mistakes are okay in your classroom.

### Discussing Fear of Failure

- Are students afraid to make mistakes?
- How do we react to their mistakes?
- Do we have class discussions about making mistakes?

Read *The Girl Who Never Made Mistakes* by Marc Pett and Gary Rubinstein

### Mistakes...

...reduce stress (“But what if I am wrong?”)

...promote experimentation (“I could try this...”)

...promote collaboration (“What did you do?”)

...build understanding (“Why didn’t that work? Why did this work?”)

...grow our brains!

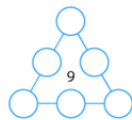
### Adopt a Class Mantra to Show Growth Mindset

- It’s okay to not know, but it’s not okay to not try.
- Mistakes help us get closer to the solution.
- It might take time, but we’ll get there.
- If at first we don’t succeed, try, try again!
- I can do this!
- Keep on going!

### Supporting Students: The Value of Timeouts

**NRICH**

<https://nrich.maths.org/>



Arrange the numbers 1-6 so the sum of each side of the rectangle is equal to the number in the center.

**Timeout:** Any tips or insights to share?

How did you get started?

Do you notice anything about the numbers that might help (e.g., odd or even)?

Do you notice anything about the corner numbers and the middle numbers?

### Debriefing After Tasks

- Turn and Share: Did anyone get frustrated and want to quit? When?
- How did you get yourself going again?

- How did you feel when you found a solution?
- What advice would you give someone else who is getting started on this task?

### **Idea to Try:**

#### **Pose journal prompts like the following**

- What was easy/hard about this problem?
- What was confusing? How did you figure it out?
- Where did you get stuck? How did you get unstuck?

### **Flip the Comment Cards**

Give each student a blank index card. Have them label the sides 1 and 2 and share their reflections.

I first thought...

Then, I realized...

I solved this by...

Next time I will...

A mistake I made...

What I learned...

### **Two-column Notes**

I learned/I still Have Questions About

I Discovered/I Still Wonder About

This was Easy for Me/This was Hard for Me

### **Selecting Tasks**

- Answer is not immediately apparent
- Multiple ways to explore the task
- Focus on process rather than answer
- Provides a challenge that is reasonable

### **Rich Problems**

- 10 children went to the movie. How many were girls? How many were boys?
- Blake had some red and yellow flowers. She had 12 flowers and more of them were red than yellow. How many of each color might she have had?
- Three children shared a pizza. How might they have shared it? What fraction of the pizza could each child get? Justify your answers.
- Molly has 6 coins in her piggy bank. She has more than 85¢, but less than \$1.10. What 6 coins could she have? Explain your answers.
- Create rectangles with an area of 24 square units. How are they alike and different? Are their perimeters the same? Explain your observations.

## Illustrative Mathematics

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

Cruz and Erica were both getting ready for soccer.

- Cruz ran 1 lap around the school.
- Erica ran 3 laps around the playground.

Erica said "I ran more laps so I ran farther."

Cruz said "4 laps around the school is 1 mile, but it takes 12 laps around the playground to go 1 mile. My laps are so much longer, so I ran more."

Who is right?

Draw a picture to help you explain your answer.

4.NF.2

## Open Middle

[www.openmiddle.com](http://www.openmiddle.com)

Use the digits 0-9 to fill the spaces.  
What solutions can you find?

$$\square\square + 45 = \square\square$$

## 3 Act Tasks

<https://gfletchy.com/3-act-lessons/>

### Pringle Ringle

<https://gfletchy.com/the-pringle-ringle/>

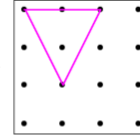


## NRICH

<https://nrich.maths.org/>

### Inside Triangles

I have joined 3 dots on the grid to make a triangle that has one dot inside.



How many different triangles with one dot in the middle can you draw?

How do you know you have found them all?



[www.mathinpractice.com](http://www.mathinpractice.com)

Pick 3 digit cards and build three-digit numbers.

- What is the three-digit number with the greatest value? Prove it.
- What is the three-digit number with the least value? Prove it.
- What is the difference between the numbers with the greatest and least values?
- How many different 3-digit numbers can you make?

## What do our students need for success?

Opportunities to explore math through tasks that may require struggle

To feel safe when making mistakes and to accept struggle as a part of learning math

Know how to persevere and recognize the value of perseverance

To develop problem-solving skills and dispositions

## Additional Resources:

Take the *With Math I Can* pledge to help every student succeed in math:

<https://www.amazon.com/gp/withmathican>

Find lots of rich tasks on You Cubed: <https://www.youcubed.org/>

Explore *Math in Practice* resources and videos on: <https://www.heinemann.com/mathinpractice/>

Join the *Math in Practice* Facebook group to explore K-5 math teaching ideas and resources!

With thinking comes struggle. Our goal is to build thinkers! Struggle is part of the process.

Teacher Resource Books by Sue O'Connell  
Published by Heinemann ([www.heinemann.com](http://www.heinemann.com))

***Math in Practice* ([www.mathinpractice.com](http://www.mathinpractice.com))**

This series is filled with lesson ideas, instructional strategies, practice tasks, and many online printable resources to make teaching K-5 math more meaningful and more fun. There is a book for each grade level K-5 that contains a wealth of grade-specific activities, as well as a *Guide for Teachers* filled with instructional strategies and an *Administrator's Guide*. Visit the website or [www.mathinpractice.com](http://www.mathinpractice.com) to view the materials.

***Putting the Practices into Action - Implementing the Common Core Standards for Mathematical Practice K-8*  
with John SanGiovanni**

The Standards for Math Practice are the heart and soul of the Common Core State Standards. This book explains each standard in teacher-friendly terms and highlights practical activities to make the standards come alive in classrooms. It contains PLC study group questions and online resources.

***Mastering the Basic Math Facts for Addition and Subtraction*  
*Mastering the Basic Math Facts for Multiplication and Division*  
with John SanGiovanni**

Through investigations, discussions, visual models, children's literature, and hands-on explorations, students explore the math operations, and through engaging, interactive practice achieve fluency with basic facts. A teacher-friendly CD filled with customizable activities, templates, recording sheets, and teacher tools simplifies your planning and preparation. Over 450 pages of reproducible forms are included in English and Spanish translation.

***The Math Process Standards Series***

Each book in this series is a practical guide for helping students refine their skills in the highlighted math process (problem solving, communication, reasoning, representations, connections). You will find specific teaching strategies and tips to help all students strengthen their skills. Included with each book is a CD filled with teacher tools and customizable student activities to allow you to change names, data, or spacing for a quick way to differentiate instruction within your classroom.

<b><i>Introduction to Problem Solving</i></b>	<b><i>Introduction to Communication</i></b>
<b><i>Introduction to Representation</i></b>	<b><i>Introduction to Reasoning and Proof</i></b>
<b><i>Introduction to Connections</i></b>	

All books in this series are available for Grades PK-2, Grades 3-5, and Grades 6-8.

***Now I Get It: Strategies for Building Confident and Competent Mathematicians, K-6***

Good teaching is the critical factor that helps students "get" math. This book is a practical handbook for the teaching of mathematics, with chapters addressing the teaching of problem solving, the use of manipulatives, differentiating instruction, effective teacher questioning, increasing math talk, and much more. The book includes a CD with over 100 pages of resources to support teachers including manipulative templates, math facts game templates, a bibliography of math-related literature, center ideas, math websites, problem-solving and writing tasks, and a variety of other practical resources.

For additional resources, visit Sue's website at [www.qualityteacherdevelopment.com](http://www.qualityteacherdevelopment.com)

**Follow Sue on Twitter @SueOConnellMath**

**Like our Facebook page – Quality Teacher Development**

**Join the Math in Practice Facebook group!**