

Critical Thinking IN MATH

FIRST BOOK 



Critical Thinking in Math

Math is sometimes viewed as the memorization of facts and procedures, followed by rote application. Students do need to memorize formulas and solve equations, but math also offers the opportunity for creativity and critical thinking skills in the form of problem-solving, questioning assumptions, making associations, and considering alternative solutions. To learn math concepts and critical thinking skills simultaneously, students must do more than follow a set of procedures — they need to engage in mathematical problem-solving that actively requires critical thinking and decision-making skills.

When math is presented as a form of inquiry and discovery rather than a set of rules leading to a single correct answer, students develop both numerical literacy and mathematical reasoning. These skills are related to and reinforce other essential academic and life skills, including:

- focused thinking, planning, and strategizing — skills key to organizational success, decision-making, and life success
- useful habits of mind like persistence, thoroughness, creativity in solution finding, and self-monitoring
- how to simplify big problems by breaking them out into smaller tasks and persevere in solving them
- how to solve problems using “what if” example cases to test assumptions

Best Practices: Critical Thinking in Math

The following teaching strategies ensure students have the opportunity to think mathematically — not simply memorize, mimic, and perform.

- Start class with hard puzzles, problems, and other thinking tasks that push kids to their limits.
- Use the Concrete, Representational, Abstract approach, particularly in elementary school. Students progress in their study of math concepts from the concrete (e.g., math manipulatives) to the pictorial (e.g., drawings, digital models) to the abstract (e.g., algorithmic).
- Use highly structured group activities to promote discussion, peer review, and iterative thinking.

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It's time to let the secret out: mathematics is not primarily a matter of plugging numbers into formulas and performing rote computations. It is a way of thinking and questioning.

JORDAN ELLENBERG,
MATHEMATICIAN
AND PROFESSOR

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**CHECK OUT
IDEAS FOR
THINKING TASKS
ON PAGE 3!**

- Use randomized groups, which have been shown to increase knowledge mobility, reduce stress, and increase enthusiasm for math. Create randomized groups using classtools.net and [Keamk](https://keamk.com).
- Assign group roles: a scribe to write down possible solutions, a representative to communicate the group's findings to the class, someone to ask the teacher questions, and a project manager to keep the group on track.
- Answer strategic questions when students ask for help: "What makes this hard?" or "What have you tried?"
- Teach mathematical problem-solving by encouraging students to think conceptually about problems before applying tools they've learned.
- Provide relevant mathematical modeling projects to give students experience in weighing several factors against one another and using mathematical knowledge to make decisions.



I tend to ask open-ended questions and give hands-on activities that require students to critically think. For example, students had trouble understanding that the denominator of a fraction determines the size of the piece. To make them understand this I brought in a sheet cake, and I had students cut it based on the fraction I gave them. Students had to then critically analyze why the larger the denominator, the smaller the piece.

ANDREA, FIRST BOOK EDUCATOR

Math Thinking Tasks

Peter Liljedahl, math educator and author of *Building Thinking Classrooms in Mathematics, Grades K-12: 14 Teaching Practices for Enhancing Learning*, recommends beginning each class with a thinking task. At the beginning of the year, the tasks should be highly engaging, noncurricular problems and challenges. As the year progresses, the tasks should have a curricular connection.

The Last Number

Consider the string 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Cross out any two numbers in this list and add the difference to the end of the list. This new number is now part of the list. Continue the process of crossing out two numbers on the list and adding the difference until there remains only one number. What can you say about the last number? Explore. [from Richard Hoshino]

1001 Pennies

There are 1001 pennies lined up on a table. I come along and replace every second coin with a nickel. Then I replace every third coin with a dime. Finally, I replace every fourth coin with a quarter. How much money is on the table?

How Many 7's

If you write out the numbers from 1 to 1000, how many times will you write the number 7?

Find more thinking tasks on [Liljedahl's website](#) and [Edutopia](#).

Lessons & Activities

The following lessons challenge students to engage in mathematical discourse and reasoning as they apply math concepts to solve real-world problems and explain their thought processes.

UPPER ELEMENTARY SCHOOL

STARTING A BUSINESS | MYPBLWORKS

This 5th-grade project-based lesson asks students to develop a business concept, conduct market research, create a realistic financial plan, and pitch their businesses to an audience. Students see how math skills can be applied to real-life scenarios as they learn key mathematical skills involving operations, grouping, and decimals and develop competence in areas of technology, communication, and collaboration.



COMMON CORE CONNECTION

Math

CCSS.Math.Content.5.OA.A.1 Use parentheses, brackets, or braces in numerical expressions, and evaluate expressions with these symbols.

MATH ESCAPE ROOM | OER COMMONS

In this math escape room lesson, students work in teams to solve a series of math puzzles and riddles to “escape” a themed room. Each puzzle is designed to reinforce key math concepts such as fractions, geometry, and basic algebra. As students solve each problem, they receive clues that lead them to the next challenge, promoting critical thinking and collaboration. The activity concludes with a debrief where students discuss the strategies they used and the math skills they applied.



COMMON CORE CONNECTION

Math

CCSS.Math.Practice.MP1 Make sense of problems and persevere in solving them. Mathematically proficient students start by explaining to themselves the meaning of a problem and looking for entry points to its solution.

MIDDLE SCHOOL

THE STATS ON STUDYING | MYPBLWORKS

This 6th-grade lesson from MyPBLWorks teaches statistical analysis and experimental design as part of an authentic investigation into which memorization technique is most effective for remembering information. After using statistics to analyze and draw conclusions about the collected data, they create and present a memorization guide for students.



COMMON CORE CONNECTION

Math: Develop understanding of statistical variability.

CCSS.Math.Content.6.SP.A.1 Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

FIRST WEEK PROBLEM SOLVING TASKS | NORTH CAROLINA COLLABORATIVE FOR MATHEMATICS (NC2ML)

These problem-solving tasks for 6th, 7th, and 8th graders develop students' listening, writing, and mathematical reasoning. Designed to be used during the first week of school, students are asked to draw on their existing mathematical knowledge and reasoning to complete the tasks.

HIGH SCHOOL

MATH, MEDIA, AND ME | PROJECT LOOK SHARP

Students analyze videos and feature film clips for messages about how mathematicians solve complex problems, our own reactions to math, and media portrayals of math problem-solving.

This lesson aligns with many subject area standards, including Library (AASL), Technology (ISTE), and Math (NCTM).



COMMON CORE CONNECTION **High School Geometry**

High School Geometry includes the concepts of how congruence, similarity, and symmetry can be understood from the perspective of geometric transformation.

YOUCUBED | STANFORD EDUCATION

Youcubed provides lessons, activities, and resources that focus on developing a growth mindset and critical thinking in math. The site encourages open-ended problem-solving and creative thinking about topics like number sense, patterns, measurement, and data.

Sources

[How to Turn Your Math Classroom Into a 'Thinking Classroom' | Edutopia](#)

[Four Teacher-Recommended Instructional Strategies for Math | EdWeek](#)

[Mathematical Teaching Strategies: Pathways to Critical Thinking and Metacognition | International Journal of Research in Education and Science](#)

[Promoting Independent Critical Thinking in Math | Edutopia](#)

[Teachers' Guide to Critical Thinking | Reboot Foundation](#)

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