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# Making Math Memorable

*Cognitive Engagement in Math*

# Table of Contents

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Click on subtitle or page number to be directed to that page.

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# Unforgettable mathematical experiences

Creating memorable mathematical experiences is more important than ever for young problem-solvers and analysts. Math is not only a set of rules and procedures; much more exists beyond a right or wrong answer. *Powerful mathematicians make connections.*

Cognitive engagement helps **make math memorable.** To successfully engage students at a cognitive level, educators must move away from using only basic computation tasks and from simply finding the single correct answer. Instead, students should be presented with multidimensional instruction that includes not just the "hows" of problem-solving but also the real-world "whys" about their mathematical learning.

Cognitive engagement in math lends itself to 21st century educational goals — and to our ever-expanding global connections. Using cognitive engagement strategies allows students to learn math on a deeper level than they would with traditional rote memorization.

Mathematical cognitive engagement is defined as the extent to which students are willing and able to complete the learning task at hand. The successful student has the ability to both understand the mathematical ideas presented and to transfer and apply that learning to new contexts. Shifting to this growth mindset will ultimately yield the best results for learning.

Istation's Indicators of Progress (ISIP™) universal screeners are designed to assess student progress. Of the five strands of mathematical proficiency identified in *Adding It Up: Helping Children Learn Mathematics*, Istation assesses:

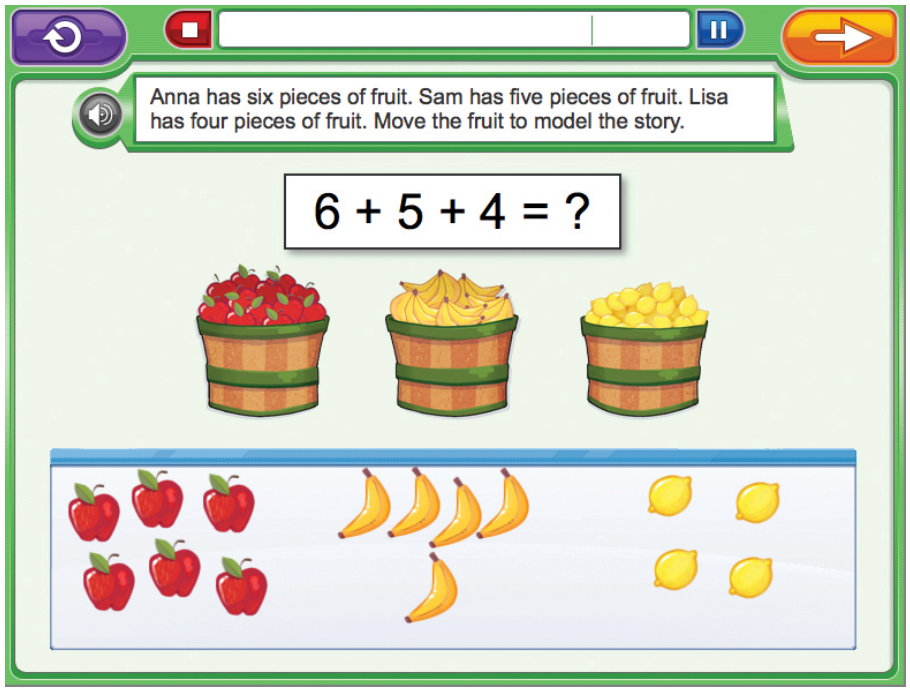
1. Strategic Competence
2. Adaptive Reasoning
3. Procedural Fluency
4. Conceptual Understanding

# There's more than one strategy to find an answer

## *Strategic Competence*

**Strategic competence** is the ability to formulate, represent, and solve problems. Students become proficient by working on a variety of problems and comfortably using different strategies to solve them.

In a widely viewed TED talk, researcher Conrad Wolfram (2010) says that 80% of school mathematics is spent performing calculations by hand. That is one skill employers do not need from their employees as it is now automated by a computer or calculator. Wolfram argues that employers need people who can ask the right questions, set up models, analyze results, and interpret mathematical answers.




*Example question from Istation's ISIP Early Math assessment*

**21st Century Mathematical Acumen**

Easy to Automate

- Although computation is easily automated, 80% of school mathematics is spent performing calculations manually.

Difficult to Automate

- Asking the right questions
- Relating real-world scenarios to math formulation
- Connecting math formulation to real-world verification

When mathematics concepts are presented through different methods and pathways, everything changes. Instead of just solving for a solution that belongs beside the equal sign, students must be able to first determine an appropriate strategy that will lead them to the correct response. Often there are multiple possibilities for finding a single solution, and the student with strategic competence is able to reason out the most effective or efficient strategy.

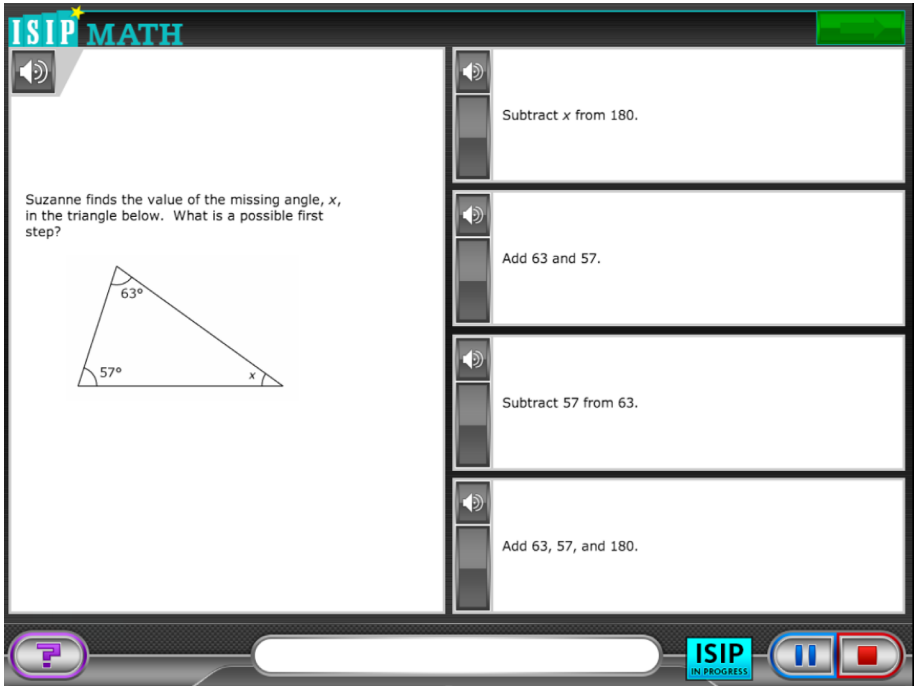
# Connect math to real life

## *Adaptive Reasoning*

**Adaptive reasoning** is a student's capacity for reflection, explanation, and justification.

Adaptive reasoning is essential to becoming a successful mathematician. The ability to think logically about whether a procedure aligns with a goal helps students justify their answers. It settles whether or not a series of steps is being accomplished correctly. A great adaptive reasoning practice is showing one's work. Proving the process by which a student arrived at an answer shows off their ability to adaptively reason!

Here are some examples of adaptive reasoning practice activities for a variety of grades:




*Example question from Istation's ISIP Math assessment*

**Adaptive reasoning examples across grade levels**

**Grades Pre-K to 4**

- Write an addition equation to describe a situation.

**Grades 5 to 8**

- Apply proportional reasoning to plan a school event or analyze a problem in the community.

**Grades 9 to 12**

- Use geometry to solve a design problem or use a function to describe how one quantity depends on another quantity or factor.

ISIP™ Math provides opportunities for students to demonstrate their adaptive reasoning proficiency. For example, this question asks what the first step is in finding the degree of an angle.

# The when and where of problem solving

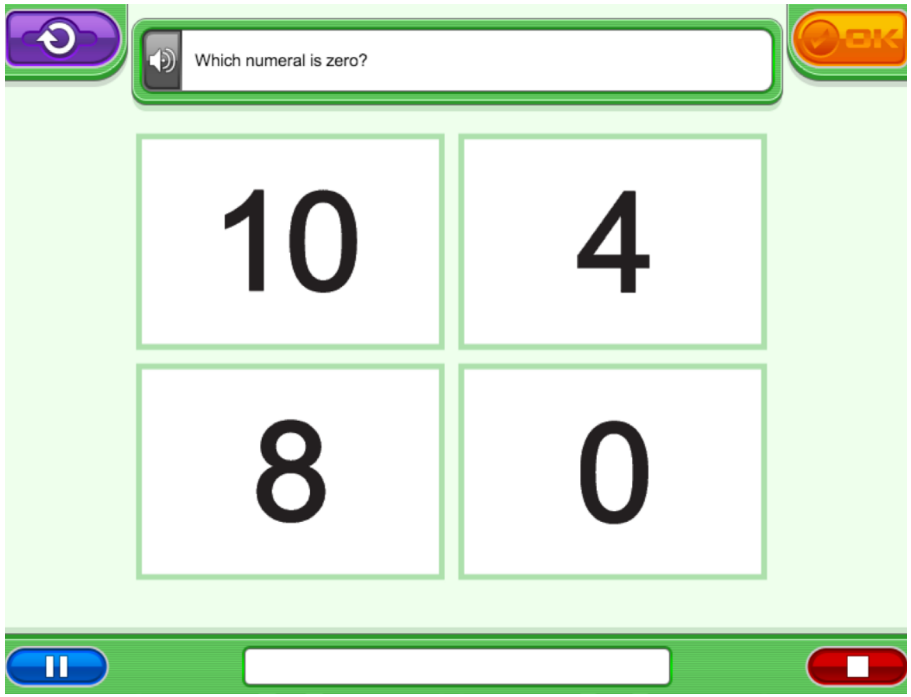
## *Procedural Fluency*

**Procedural fluency** is the skill in carrying out mathematical procedures flexibility, accurately, and appropriately.

If a student has a solid grasp of how to solve a problem in a variety of contexts (strategic competence) and is able to visualize and connect that problem to real-world scenarios (adaptive reasoning), but the student has not mastered the correct procedures and applications for answering a math question, then it may be difficult for the student to easily pick up new concepts and techniques.

Procedural fluency is an important part of overall mathematics understanding. The development of automaticity in basic mathematical procedures and concepts — such as knowing basic facts — facilitates a student's ability to strategically solve, apply, and adapt in a mathematical world.

Students who lack procedural fluency often find themselves also lacking the stamina to maintain higher levels of mathematical understanding because they get bogged down by processes that should be fluent and automatic for them.




*Example question from Istation's ISIP Math assessment*

You can see procedural fluency represented in ISIP™ Math items. Students' basic understanding of number sense concepts and their computation skills are assessed as well.

# Track student comprehension

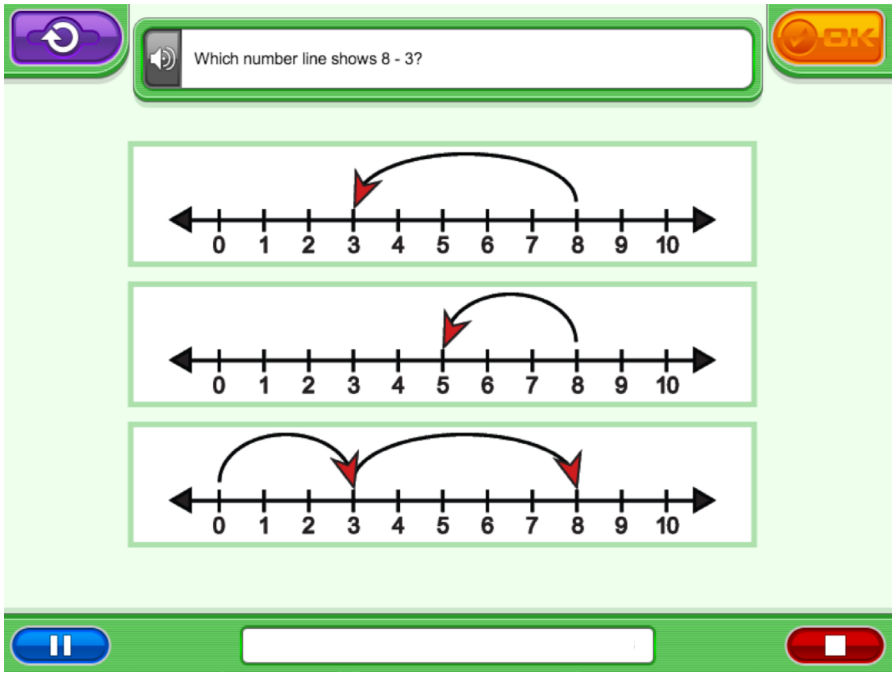
## *Conceptual Understanding*

**Conceptual understanding** is the comprehension of mathematical concepts, operations, and relations.

When a student is able to connect various representations of a math concept and prove how they are similar and how they are different, then they have a grasp of conceptual understanding. The extent of students' conceptual understanding is measured by the richness and detail of the connections they have made.

For example, when students are converting a mixed number to an improper fraction, they might use objects or draw number lines to show how both numbers represent the same amount. When students can identify commonalities and patterns within a concept, they can link these ideas in more complex future scenarios.

The computer-adaptive design of Istation's math assessments incorporate items that challenge students' conceptual understanding and their translation of mathematical ideas.




*Example question from Istation's ISIP Early Math assessment*

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# Memorable math made easy

## *Istation in the math classroom*

Tai Rodney is a 1st grade teacher at Taylors Creek Elementary School in Georgia. She drives home conceptual understanding with Istation Math's comprehensive assessments and reporting.

> *"Istation Math is very user friendly, which is a plus for me. Once I dove in, I was able to see how easy it is to work with and truly enjoy the immediate graphs and student tiers generated, which I am able to use as comparison charts to other assessment tools I use in the classroom."*

Istation Math's web-based reporting provides formative insight to guide instructional decision-making and intervention strategies. Additionally, Istation's reporting of students' cognitive engagement links to critical instruction. Teacher-led lessons and supplemental materials are also available to help improve student growth in key concept areas.

An instructor must regularly monitor students for progress in conceptual understanding to guide instructional decision-making and intervention strategies. A great tool for pinpointing student abilities and comprehension is the Ability Growth by Tier Report. This assessment report tracks the progress made by students through the current month as measured against performance goals within tier groups, allowing instructors to gauge their students' range of conceptual understanding based upon their specific tier.

Suggested uses for the ISIP™ Ability Growth by Tier Report:

- Monitor class tier movement by skill and overall mathematical ability.
- Monitor class progress in skill acquisition.
- Identify the level of student support needed.
- Evaluate effectiveness of instructional support.

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# Test your knowledge of mathematical cognitive engagement!

## *Quiz: Are You a Cognitive Engagement Guru?*

Now that we've covered the four strands that are key to inspiring and supporting strong mathematicians, self-assess to reinforce the knowledge you've taken away!

1. **Which cognitive strand of mathematical proficiency most directly assists with connecting math problems to real-world scenarios?**
   a. Procedural Fluency
   b. Conceptual Understanding
   c. Adaptive Reasoning
   d. Strategic Competence

2. **True or False: It is best to teach students one method for solving a problem.**

3. **What type of math problem is best for assessing procedural fluency?**
   a. a word problem
   b. comparing and contrasting a concept
   c. translating a concept into a graphical representation
   d. a basic computation task

4. **True or False: According to researcher Conrad Wolfram's 2010 TED talk, 80% of school mathematics is spent performing calculations by hand.**

5. **What is a common misconception educators often have about math?**
   a. Math is centered on problem solving.
   b. Math is a subject of rules and procedures.
   c. Making real-world connections is an important component for mathematical proficiency.
   d. One must pose the right questions when assessing a math problem.

Answer Key:
1. c.
2. *False.* To become proficient in a mathematical concept or skill, students must possess strategic competence. This is the ability to formulate, represent, and solve mathematical problems. Students become proficient by working on a variety of problems and comfortably using different strategies to solve them.
3. *d.*
4. *True.*
5. *b.*


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