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Description automatically generated with medium confidenceMath Understanding: Helping Students Think Conceptually

**Implementation Guide**



**The Math MUSTs**

MUST is an acronym for four tools you can use to build students’ confidence in math and nurture a can-do attitude:

* **M** is for the **messages** students get about math and their ability to learn it.
* **U** is for **understanding** math concepts and how thoughts and emotions affect learning.
* **S** is for **skills** that help you learn and use math — and manage anxiety, if it’s an issue.
* **T** is for **thrills** because students need positive experiences to help them discover the magic and satisfaction of math in a way that’s meaningful to them.

**What to do:** Read this guide to learn about ways to build students’ conceptual understanding of math. Consider ways to use your current math knowledge and life experiences to help them grasp some of math’s big ideas, like estimation and measurement. Ask your students’ school-day math teachers what concepts students are learning so that you can reinforce those ideas.

**Why it matters:** It’s important for students to know how to solve math problems. That’s called procedural knowledge. But it also helps if they understand *why* those procedures work. That’s called conceptual understanding, and it can increase their math understanding and confidence.

# Understanding Math Concepts

Students need these three kinds of knowledge to learn math and to apply what they learn:

**Procedural fluency:** Knowing about math formulas and how to use them to solve a math problem.

**Conceptual understanding:** This helps students to go beyond memorizing math procedures to understand why and how those procedures work. Once you have conceptual understanding, math starts to make sense, and you can apply what you know about math to different problems and situations.

**Problem solving:** This is the ability to apply procedural fluency and conceptual understanding in flexible ways to solve problems.

# Why Conceptual Understanding Is So Important

Math today puts more emphasis on conceptual understanding than it did in the past. Here are three reasons why conceptual understanding is so important:

* **Reason #1:** It gives you the **insight to apply what you know** about math procedures (like the procedure for dividing fractions) to new problems and situations.
* **Reason #2:** It helps you **understand why a math procedure works**, and math makes sense. This can boost confidence and decrease anxiety.
* **Reason #3:** It’s part of **number sense** (the ability to understand, connect, and relate numbers) so you can find ways to solve the problem even if you can’t recall the procedure for dividing fractions.

**Example: Clearing the Mental Fog to Solve a Math Problem**

**Problem:** Divide a dozen eggs evenly into three baskets and tell how many eggs are in each basket.

**Procedural fluency:** Translate the word problem into a math equation where x shows the unknown value: A dozen means 12, so the equation for this word problem is   
12 ÷ 3 = x

**Conceptual understanding:** Explain the idea behind the word problem or math equation: You’re really saying, “How many 3’s are there in 12?”

**Problem solving:** Use knowledge of math procedures and concepts to solve the problem and justify your answer: “Put four eggs in each basket because 12 ÷ 3 = 4.”

# Examples of Important Math Concepts Used in Everyday Life

You likely already know and use some big math concepts in your everyday life. You can use that knowledge to enrich your current program activities while helping students understand big ideas that are part of math at every grade level. Here are some examples:

## Equivalence

* **Definition:** There are infinite ways to represent any number, measure, numerical or algebraic expression, or equation.
* **In a math activity:** All the following numbers and expressions are equivalent to the number two: 2, 2.0, 2/1, square root of 4, 1/6 of a dozen, 4 ÷ 2, 100 ÷ 50. These are just a few examples. I bet you can think of more! Try this with other numbers too, especially 10 and 100: *How many ways can you write an expression that equals 10? How many number combinations can you come up with that equal 100?* **Also:** Help students understand the “equals” sign is a way to show that what’s on each side of the “=” are equivalent. Many students think the sign means “put the answer on the right side of the sign.” This can cause confusion as they take more advanced math classes. Give them experience filling in the blank or box or question mark on the *left* side of the equals sign, like this: ? + 3 = 17. Or, use a balance scale with cubes to give students a physical example of equivalence.
* **In daily life:** At the grocery store, if you pay in cash and they give you 50 cents change, you might get two quarters, or a quarter + two dimes + a nickel, or some other combination of coins equivalent to 50 cents.

## Comparison

* **Definition:** You can examine the differences between numbers, quantities, or values and compare them to decide if one is greater than, smaller than, or equal to another.
* **In a math activity:** Which number is larger, 10 or 100? Which cup holds more liquid, the pint cup or the quart cup? How does a fluid ounce compare to a dry ounce? A fluid ounce refers to volume (how much space the fluid takes up), while dry ounces refer to weight (how much something weighs).
* **In daily life:** Which shoes are longer from heel to toe, U.S. men’s size 6 or U.S. women’s size 10? How do “medium” and “large” drinks compare at a single restaurant? At different restaurants?

## Estimation

* **Definition:** You can replace numbers in an equation with other numbers that are close but easier to compute mentally.
* **In a math activity:** For 250 + 298, since 298 is almost 300, add 250 + 300 to get an estimate of 550. For 19 + 23 + 21 + 24 + 18, since all the numbers “cluster” around 20, multiply 5 x 20 to get an estimate of 100.
* **In daily life:** Sometimes an estimate is all you need to solve a problem (*About how many hot dogs should we order for the picnic?*), and sometimes an estimate can help you make sure your answer to a problem makes sense (*Is my answer close to what I estimated?*).

## Measurement

* **Definition:** Some things in the physical world can be measured and quantified. There are measurement systems for length, weight, time, substance, temperature, luminosity (intensity of light), and electric current.
* **In a math activity:** Experiment with a variety of instruments to measure length, distance, mass, time, and temperature. For example: A football field is 100 yards long. The area of a room is given in square feet. The volume of a box, tube, or other three-dimensional object can be measured in cubic feet, or sometimes in liquid measures like liters or quarts. Time can be measured in seconds, minutes, hours, days, years, centuries, and so on. Temperature is measured in degrees, whether on the Celsius or Fahrenheit scale. Most of the world uses the metric system, not the U.S. customary system of weights and measures. Various professions have established measures to meet their needs — for example, carats to measure jewels, Kilowatts to measure energy, and the Richter scale to measure the magnitude of an earthquake.
* **In daily life:** When cooking or baking, it’s important to know the difference between dry measures and liquid measures. If you’re buying a house, the size (area) is usually given in square feet. The windchill index takes air temperature and wind speed into consideration. If your airline ticket indicates a 6 a.m. Eastern Time departure from Washington, DC, and a 10 a.m. Pacific Time arrival in Los Angeles, CA, the actual flight time is 7 hours (not 4 hours) because you’re traveling across time zones. Construction crews need to know about sandpaper weights, standard drill bit sizes, lumber sizes, wood screw sizing, and more. Mechanics need to know about standard tire measurements, wrench and socket sizes, revolutions per minute (RPM), and more.

## Patterns

* **Definition:** Relationships between numbers or objects that repeat in predictable ways, according to a certain rule.
* **In a math activity:** Any number multiplied by 2 is twice as large as the original number, and any number multiplied by ½ gets smaller. In the following number sequence, all the numbers are odd: 1, 3, 5, 7, 9, 11, 13, 15. In this sequence, the numbers are sequential and in ascending order: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. Noticing patterns can help you make generalizations about numbers, properties, shapes, and so forth.
* **In daily life:** Pattern recognition is part of every aspect of your day, from matching your socks in the morning to searching the night sky for star patterns known as constellations. Patterns are evident in other ways too: When you learn to read, you recognize letter combinations as words, and word combinations as sentences. Scientists classify plants and animals based on certain common characteristics. Economists predict the impact of economic trends by looking for patterns in data. Artists create patterns with color, line, texture, and shape.

## Variables

* **Definition:** A variable is a symbol or letter (like *x* or *y*) that represents a value you don’t know yet. (Sometimes it helps to remind students that it’s no different than the \_\_\_ in the number sentences they did when they were younger.) A letter can also represent a *constant* (something that doesn’t change).
* **In a math activity:** In the equation 3 + 4 = *x*, you need to add 3 + 4 to determine the value of *x*. In this equation, the value of the letter *x* is 7. But *x* doesn’t always mean 7. The letter *x* doesn’t have a fixed value, so in a different equation (like 4 + 4 = *x*), the value of *x* is 8.
* **In daily life:** If someone asks, “How many days are in 10 weeks?” you already know there are 7 days in 1 week, so you could write this problem as an equation and use an *x* to represent the unknown value, like this: 7 x 10 = *x*.

To learn more about the math MUSTs, see these tools in the 21st CCLC NTAC Math Toolkit:

* **Math Anxiety and Four MUSTs for Addressing It**
* **Math Messages That Build Confidence**
* **Math Skills for Students to Learn and Practice**
* **Math Thrills: Putting Fun Into the Equation**

*To not know math is a severe limitation to knowing the world.*

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Description automatically generated— Richard P. Feynman

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