



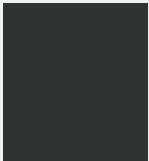
# Exploring Our World of Math: Empowering and Inspiring Students with Authentic Learning

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Mathematics is everywhere. In both our personal and professional lives, mathematics is all around us. It is in the complex work of urban planning, the air flow engineering of an airplane’s cabin, the comparing and contrasting of gasoline-powered versus electric vehicles, the health and environmental analysis of pesticides used on crops, the motion tracking and design of virtual reality experiences created to teleport students and adults to immersive experiences that would never be possible in the real world, and so much more. As educators, it is our job to help illuminate the invisible forces of math all around us. Such illumination requires engaging students in authenticity or authentic learning. Authentic learning experiences that occur during core mathematics instruction can either take place in the real-world or have direct applicability to real-world contexts. Both options let students “experience the same problem-solving challenges in the curriculum as they do in their daily endeavors” (Herrington et al., 2014, p. 402).

## ABOUT THE AUTHOR



An expert on equitable teaching and authentic learning in mathematics, Sarah B. Bush, Ph.D., advocates for a whole-school approach to collaborative and cohesive high-quality math instruction. She previously taught middle school math and now teaches educators at the graduate level.

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The big idea is that the problem is grounded in the real world but open for interpretation, complex enough to require sustained work with the help of peers, layered to require reflection, and results in a variety of tangible solutions.

—(Roberts & Chapman, 2017, p. 16)

Inspiring, authentic learning opportunities are indispensable for students for a multitude of reasons:

**A he i c i c l i a e b e l f g i g** in mathematics (and STEM more broadly) and empowers students to become solution seekers inspired to make our world better (as described in Jackson, Cook, et al., 2024; Jackson, Roberts, et al., 2024).

**A he i c i f e i e g a e d l e a i g** by providing tangible opportunities for students to witness and appreciate the utility of mathematics in their daily lives.

**A he i c i e i c h e e e c i e e a c h e a d d e m a t h e m a t i c a c t i v i t y** through intentional opportunities for students to experience mathematics in high-quality, context-rich ways.

**Sample Authentic Contexts in *California Reveal Math*<sup>®</sup>**

<b>Authentic Learning Context</b>	<b>Connecting to the Mathematics</b>	<b>Grade Band</b>
Animals in the World Around Us	Sorting, Data Analysis, Addition and Subtraction Strategies	K–2
Transportation	Measurement, Addition and Subtraction	K–2
Recycling	Data Collection	3–5
Groceries	Estimating Decimals	3–5
City Planning	Scale, Geometry, Proportional Reasoning, Angles	6–8
Gasoline vs. Electric	Linear Expressions and Equations	6–8
Bicycle Sharing	Linear and Nonlinear Functions	9–12
Sustainable Building	Polynomial Equations	9–12

## A he ici C l i a e Bel g i g

The concept of cultivating belonging in STEM is not new. In fact, the United States Department of Education has promoted this idea through the “YOU Belong in STEM” campaign, part of the Raise

overcoming challenges to get where they are today. Students benefit from seeing that they can arrive at success in many different ways and that the pathway is not always clear-cut or linear.

Consider teaching mathematics ideas alongside STEM-centric literature for children and young adults to help forge authentic connections and structure exploration. There are countless examples of STEM-centric literature for students, but one of my favorites is a book series entitled "Powerful Mathematicians Who Changed the World" (edited by *Real Math*<sup>®</sup> author Christa Jackson, 2023), which highlights diverse mathematicians and their authentic contributions to the world.

## Authentic Learning

Authentic learning naturally lends itself to an integrated approach. As students explore mathematics in authentic ways, they are learning about its role and implications in many fields, careers, and aspects of our everyday lives (Bush & Cook, 2025). For example, mathematics plays an essential role in nature, medicine, athletics, music, engineering, home improvement projects, social media and influencer algorithms, and so much more.

You may be familiar with integrated approaches that have become commonplace and that, depending on their implementation, may fall under the umbrella of authentic learning. These include Inquiry-Based, Problem-Based, Project-Based, Place-Based, Real-World, Situation-Based, Engineering Design, Design Thinking, and more. If your school has adopted one of these approaches, it makes sense to consider how authentic learning in mathematics fits within that approach. Most important, though, is that students have high-quality experiences authentically exploring mathematics.

Integrated learning, and specifically integrated STEM learning, can improve student outcomes in STEM in a variety of ways (Bybee, 2013; National Research Council; 2011, 2013). Outcomes in Design

<b>Mathematics Teaching Practice (NCTM, 2014)</b>	<b>Ideas, Strategies, and Questions to Guide Authentic Learning Opportunities</b>
Establish mathematics goals to focus learning.	

<p>Use and connect mathematical representations.</p>	<p>Brainstorm an authentic learning opportunity for your students. What mathematical representations would be helpful and meaningful to students to make sense of both the authentic context and the mathematics?</p> <p>How could using multiple representations and students making connections across those representations help deepen the impact of an authentic learning opportunity?</p>
<p>Facilitate meaningful mathematical discourse.</p>	<p>In what ways will your whole-class, small-group, peer-to-peer, and teacher-to-student discourse include conversation that links the authentic context to the mathematics and the mathematics to the authentic context?</p> <p>In what ways can mathematical discourse facilitate a sense of belonging and confidence in mathematics and STEM? How can classroom discourse around authentic learning continually connect to the application of mathematics and explore ideas students are curious about?</p>
<p>Pose purposeful questions.</p>	<p>As you develop purposeful questions to advance and assess student thinking, in what ways will asking questions in relation to the authentic context help empower students as problem-solvers?</p> <p>What are some sample sentence stems or questions you can think of that either assesses or advances student thinking within an authentic learning experience (capturing both the mathematics and context)?</p>
<p>Build procedural fluency from conceptual understanding.</p>	<p>Consider the points during an authentic learning experience where you will conceptually dig into the mathematics, where you will build procedural fluency from conceptual understanding, and during which students will consider the mathematics in authentic context.</p> <p>How can conceptual understanding and procedural fluency build a greater appreciation for the mathematics revealed during authentic learning opportunities? How will this be highlighted with students?</p>

<p>Support productive struggle in learning mathematics.</p>	<p>Consider an authentic learning opportunity and think about points at which students might get stuck or struggle. What supports, both mathematically and contextually, can you put into place to support their learning?</p> <p>How might an authentic learning opportunity remove barriers to learning mathematics? What potential new barriers should you be on the lookout and ready for?</p>
<p>Elicit and use evidence of student thinking.</p>	<p>As you elicit and use evidence of student thinking, how can you honor the contextual past experiences that students bring to the authentic learning opportunity?</p> <p>As you elicit and use evidence of student thinking, how can you ensure a variety of perspectives, possible solutions, and strategies are encouraged and valued?</p>

**California Course : The 2023 Mathematical  
Practices**



As you prepare for your next unit or lesson, consider how you can integrate authentic, transformative mathematics learning experiences into your instruction. Whether by inviting guest speakers to discuss their STEM journeys or illuminating mathematics in our world through community needs, research, and stories, your students will benefit immeasurably from discovering mathematics all around us. We hope this white paper will serve as a helpful tool as you engage your students in authentic learning of mathematics!





