

Three questions from CCTM teachers about mathematical modeling

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ARTICLE

Abstract: This article shares three questions and answers about mathematical modeling in the classroom from an April 2020 online conversations with participants of a CCTM webinar. We hope that the answers to these questions will motivate teachers to embrace the value of implementing math modeling tasks, help students see the math all around them in the world, and empower future professionals to reach for the mathematical tools in their pockets to make data-driven decisions.

Keywords: mathematical modeling, Pre-K-12 teaching strategies, Standards for Mathematical Practice, SMP₄

The three questions in this article are based on an April 2020 online conversation with participants of [a CCTM webinar](#). We welcome further questions and dialogue and welcome readers to contact us using information in our bios at the end of the article.

QUESTION 1: WHAT EXACTLY IS MATH MODELING?

The Guidelines for Assessment and Instruction in Mathematical Modeling Education (GAIMME) defines mathematical modeling as a practice that “uses mathematics to answer big, messy, reality-based questions” (GAIMME, 2016, p. 7) and explains that mathematical modeling is a process that uses mathematics to represent, analyze, make predictions, or otherwise provide insight into real-world phenomena. The Common Core State Standards for Mathematics (CCSSM) address modeling directly as one of the eight Standards for Mathematical Practice (National Governors Association [NGA] Center for Best Practices & Council of Chief State School Officers [CCSSO], 2010). The high school standard states “Modeling links classroom mathematics and statistics to everyday life, work, and decision-making. Modeling is the process of choosing and using appropriate mathematics and statistics to



analyze empirical situations, to understand them better, and to improve decisions” (NGA & CCSSO, 2010, p.72).

To engage students in genuine decision-making, teachers can find, cultivate, and present tasks that are open and rich in context. Tasks should interest students and help them explore the WHY behind the mathematics, while strengthening sense-making and retention over time. To do so, we need to choose situations for students to model that contain appropriate mathematical targets, multiple entry points, a variety of solutions, and an audience or “client” who will care about the solution. Student solutions should require justification as to how their model can help this client.

QUESTION 2: I AM INTRIGUED WITH MATH MODELING – WHERE DO I START?

Through modeling students see that mathematics is everywhere and not just between the covers of their mathematics textbooks. Building students’ perspective on the mathematics in their world can open their minds to fun, creative, and inspiring challenges. Students develop ownership of mathematics as they engage in relevant and messy modeling tasks, which can build from smaller challenges, such as:

“Where’s the math/What do you notice and wonder?” Choose pictures from your community, such as a family-owned restaurant, playground, sports game, or landmark. Students practice mathematical noticing, justifying, and communicating by looking at the displayed image and sharing where they see mathematics. They may see angles, objects to be counted, and so forth (e.g., Figure 1).

“Which one doesn’t belong? Why?” A routine, inspired by Danielson (2016), asks students to look at a quartet of images and determine a reason why each one does not belong with the others. This valuable activity gives students awareness that there is not always a single right answer in mathematics and the importance of justification. (For more examples, see <https://wodb.ca>.) Once students learn how to do it, they can make up their own versions (e.g., Figure 2).



Figure 1. Example image for the activity, “Where’s the math/What do you notice and wonder?” Reprinted with permission. Photo by Roxanne Shewchuk for Pexels.

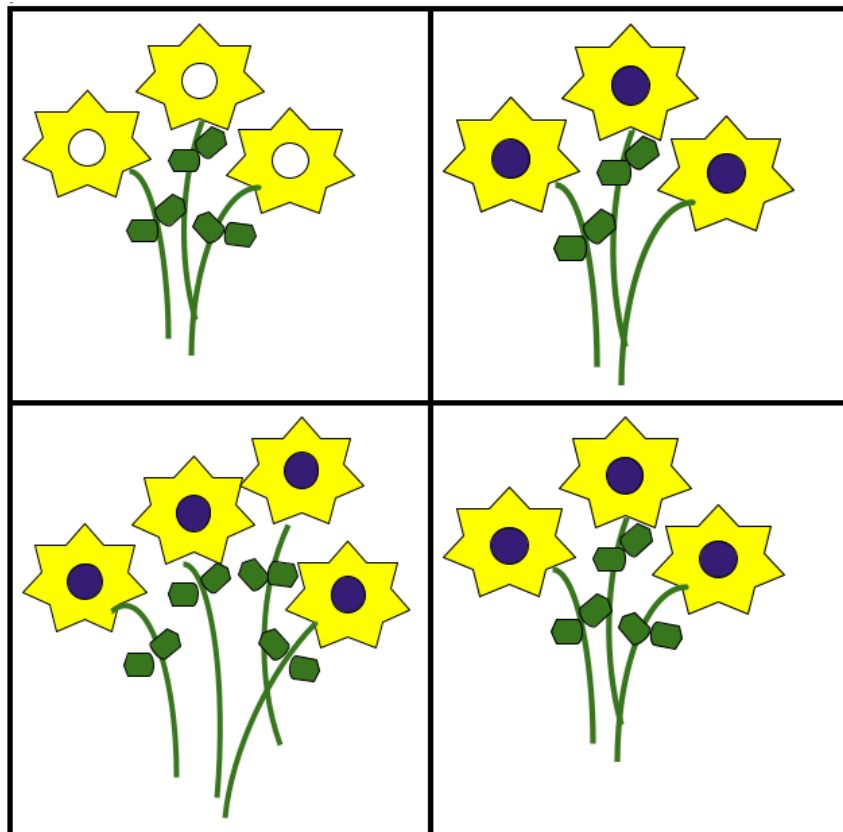


Figure 2. An example of “Which One Doesn’t Belong? Why?”

Center a mini-task in your classroom. These tasks are related to students' reality in school and help them to develop decision-making in which they are the client.

Another way to create a more open task is to remove some of the information from problems in your textbook. This openness in a mathematics task will allow students to consider relevant quantities, how to unitize them, what range of values might be reasonable, and so forth. Openness can also provide opportunities for students to choose their own problem approach and solution strategies.

Consider this typical multi-step third grade math problem from a textbook: *You have paid the cashier 2 twenty-dollar bills for a \$28.50 purchase. What will your change be?*

By removing information and assigning a meaningful client the task could become: *We (as a class/client) will have a snack at the end of the day on Friday. I (the teacher) have a budget of \$20. What should we plan to eat?*

The mathematical learning objective of adding and subtracting with money remains, yet the students need to consider many aspects of the situation such as the number of students, nutrition, available coupons or discounts, allergies, and so forth. There is not one right answer, but there will be one that seems best and will ultimately win the vote of the class/client.

Another strategy for creating a modeling task is to use an image from the above-mentioned activity "Where's the Math/What do you notice and wonder?" and ask students to model something within the context of the image. For example, consider Figure 1. We could ask, how much would it cost to care for a camel? And as an expansion of this question, we could ask: how would the amount change if you had cows instead of camels?

As a teacher, allowing multiple pathways and solutions may feel messy. But beyond the messy, you will find students beginning to consider themselves to be mathematicians as they make choices and engage in more complex, meaningful tasks.

QUESTION 3: I HAVE A VERY STRICT PACING GUIDE THAT I AM REQUIRED TO FOLLOW – WHEN DO I FIT THIS IN?

The amount of time a mathematical modeling task takes depends on its size and complexity. Some teachers make mathematical modeling tasks part of their weekly teaching cycle, trading out repetitive practice pages for a meaningful task instead. Another suggestion is to use modeling tasks as a culminating two- or three-day activity to wrap up a unit. Larger tasks can take a week or more and could be used to wrap up a semester.

No matter how you choose to fit it in, mathematical modeling will be invaluable to show students how the mathematics they are learning in a textbook applies to the real and to their world. Tasks also often reveal what students have learned and can apply from past lessons. Incorporating modeling into your mathematics curriculum can save instructional time by addressing multiple standards at once and developing deeper, more lasting student understanding of content.

We hope, as the GAIMME report recommends, you will dive into mathematical modeling and “Start Big, Start Small, Just Start” (Garfunkel & Montgomery, 2016, p. 21).

SOME RESOURCES

The following list provides some resources on mathematical modeling:

- **Math Modeling Hub:** A free online community platform to exchange ideas with other teachers from kinder to university level: <https://qubeshub.org/community/groups/mmhub>
- **Mathworks Math Modeling Challenge (M3):** Mathematics modeling competition for high school students and its website include many resources, videos, example problems and solutions: <https://m3challenge.siam.org/>
- **Consortium for Mathematics and its Applications (COMAP):** A website with teaching modules and mathematical modeling competitions for high school and college: <https://www.comap.com/>
- **GAIMME report:** A free set of guidelines for teaching and assessing modeling with teacher voices and separate sections for different grade bands: <https://www.siam.org/publications/reports/detail/guidelines-for-assessment-and-instruction-in-mathematical-modeling-education>

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<http://www.corestandards.org/Math/Practice/>



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