

Oregon Math Project

Practice Brief: Mathematical Modeling

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What is the Issue?

A primary task of mathematics educators is to support students in understanding the usefulness of mathematics outside of the classroom setting. Mathematical modeling is one way we can utilize math to analyze situations, create and test solutions, and make decisions based on sound reasoning. Researchers have explored how students at all grade levels can successfully engage in mathematical modeling. However, they are still exploring how teachers can engage students in authentic modeling tasks. This practice brief shares ideas in support of mathematical modeling, opportunities for students to see the usefulness of mathematics connected to their communities and lives, and emerging ideas for modeling instruction.

Why it Matters:

- **Bringing the classroom into the community**: Mathematical modeling asks students to engage with rich, complex problems. Incorporating tasks and scenarios that are directly relevant to students' lives and communities are opportunities for students to see themselves echoed in the curriculum. They are able to draw upon their varied expertise and funds of knowledge to solve problems which can lead to richer mathematical discourse. Authentic modeling tasks can also help students learn to analyze current issues using mathematics and to determine and communicate solutions to stakeholders.¹ Modeling can be a space for learning mathematics and learning about the world.
- **Opportunities to develop student agency and mathematical identities**: Modeling tasks align well with recommendations for increasing agency and identity in mathematics.² When students are actively engaged in the lesson they deepen their understanding and see themselves as mathematically capable.³ Teachers can increase opportunities for student agency and voice in the learning process by providing choice in tasks and centering modeling on contexts in which students have experience and interest. Building mathematical identities can occur through the use of relevant contexts and explicit recognition of the way students are engaged in their own and others' mathematical reasoning.
- **Building mathematical proficiency**: School mathematics is often experienced as memorization and carrying out procedures. Mathematics is more than this! It includes cultivating reasoning and justification, strategically examining problems, identifying reasonable solution paths, iterating solutions, and persevering through problems. Mathematical modeling directly connects to these elements of mathematical proficiency and asks students to experience mathematics as a cycle of initiating a problem, identifying assumptions and variables, using mathematical tools and representations, analyzing a model for given situations, and validating a model for the initial problem or refining the problem to begin the cycle again.³ Students who engage in modeling tasks begin to see mathematics as a way of reasoning and doing mathematics that involves mistakes and revision, rather than only a focus on getting an answer. Mathematical modeling actively engages students to see the usefulness of math.⁴

Big Questions:

1. How are we providing opportunities for students to engage in the cycle of mathematical modeling?
2. How is mathematical modeling different than using a mathematical representation?
3. How do we assess students' modeling process as opposed to focusing on just the model?

In Oregon & Beyond:

- **Oregon's Pilot of High School 2+1 Math Pathways:** The '2' of '2+1' is the first two years of high school mathematics that integrates modeling across all mathematical domains. The '1' is a variety of advanced mathematics courses aligned to student interest and college and career aspirations that also may integrate mathematical modeling in authentic ways.
- **Math in Real Life (MiRL) & Pilots of the First Two Years:** Oregon teachers are exploring ways to incorporate math modeling in their classes. MiRL teachers have designed projects that allow students to engage in robust mathematics and explore their communities. Other MiRL teachers have designed *mathematical modeling routines* to use with a variety of math tasks across math curricula. These routines are being shared across districts.
- **GAIMME Report and Math Modeling HUB resources:** The GAIMME report provides an in-depth exploration of the modeling cycle and ways to assess math modeling available via COMAP.³ The Math Modeling Hub is an online community with K-16 modeling tasks.

Future Steps:

- **Incorporate routines and build norms for participation in each step of the modeling process:** The modeling cycle is complex and can be overwhelming to do immediately with students. Incorporate instructional routines that focus on specific elements of the modeling cycle can support both teachers and students to get started with modeling. Two routines for mathematics modeling developed by Oregon teachers ask students to (1) consider assumptions, variables, and parameters that lead to a model and (2) analyze a model and consider its validity by coordinating a justification with assumptions and parameters. Teachers have found that these routines can be used with content more familiar to teachers and students before launching an authentic modeling task. Preparing for each step of the modeling cycle by organizing resources, anticipating student methods, and developing discussion questions is essential to supporting students modeling.²
- **Modifying task to become modeling tasks:** Typical mathematics tasks in textbooks can often be modified to become modeling tasks by removing scaffolds or steps in problems.⁶ To support students' engagement in modeling ensure tasks involve communicating with others, developing strategies, asking good questions, and persevering when solutions are not obvious.
- **Connect to community and student interests:** Math is everywhere. Using the local newspaper and community issues, especially on topics of interests to students or where they spend their time outside of school, is a great source for modeling tasks.¹ Provide opportunities for students to do research into questions of interest. Use modeling as a way to develop, analyze, and justify solutions. Encourage and support students to bring those solutions to the appropriate stakeholders.

¹Aguirre, Anhalt, Cortez, Turner, & Simic-Muller. (2019). Engaging Teachers in the Powerful Combination of Mathematical Modeling and Social Justice: The Flint Water Task. *Mathematics Teacher Educator*, 7(2), 7. <https://doi.org/10.5951/mathteaceduc.7.2.0007>

²Hernández, M. L., Levy, R., Felton-Koestler, M. D., & Zbiek, R. M. (2017). Mathematical Modeling in the High School Curriculum. *The Mathematics Teacher*, 110(5), 336. <https://doi.org/10.5951/mathteacher.110.5.0336>

³Horn, I. S. (2017). *Motivated: Designing math classrooms where students want to join in*. Portsmouth, NH: Heinemann.

⁴Garfunkel, S., & Montgomery, M. (2016). *GAIMME: Guidelines for assessment & instruction in mathematical modeling education*.

⁵Tran, D., & Dougherty, B. J. (2014). Authenticity of Mathematical Modeling. *The Mathematics Teacher*, 107(9), 672. <https://doi.org/10.5951/mathteacher.107.9.0672>

⁶Wendt, T., & Murphy, K. (2016). Integrating Modeling Steps into the High School Curriculum. *The Mathematics Teacher*, 109(5), 374. <https://doi.org/10.5951/mathteacher.109.5.0374>

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