What is Math Modeling? (And Why Should You Care About It?)

Mathematical modeling refers to the process of creating a mathematical representation of a real-world scenario to make a prediction or provide insight. There is a distinction between applying a formula and the actual creation of a mathematical relationship.

Real-world, messy problems can be approached with mathematics, resulting in a range of possible solutions to help guide decision making. Both students and teachers are sometimes uncomfortable with the notion of math modeling because it is so open-ended. So much unknown information seems prohibitive. And what factors are most relevant? But it is this open-ended nature of real-world problems that leads to building and applying problem solving skills, creativity, innovation, and mathematics.

Time management can be challenging in developing a reasonable model. Arriving at assumptions that are meaningful and establishing mathematical relationships between variables that make sense in terms of units are important, as is using appropriate tools for your work and not overcomplicating your approaches. Dealing with data is another area where assumptions may need to be made due to lack of data or to data sets being too large or messy for the tools available. Reflecting on your work, and honestly identifying weaknesses in an effort to point a path to improving the model, even if you do not have the means to move forward, is a great way to demonstrate understanding and next steps needed.

Mathematical modeling can be thought of as an iterative process made up of the following components. (Note that the word "steps" is intentionally avoided: there is no prescribed ordering—some may occur simultaneously and some may be repeated.)

- **Identify the Problem**—Be specific in defining what you would like to find out.
- **Make Assumptions and Identify Variables**—It is impossible to account for all the important factors in a given situation; you must make choices about what to incorporate in your representation of the real world. Making assumptions helps reveal the variables to be considered and reduces their number by deciding not to include everything. Relationships between variables will emerge based on observations, physical laws, or simplifications.
- **Do the Math**—Eventually, a relationship between input and output will allow for a solution to be found.
- **Analyze and Assess the Solution**—Consider the results and insights gained from the model. Does the answer make sense?
- **Iterate**—Usually the model can be refined and the process can be repeated to improve performance.
- **Implement the Model and Report Results**—Make the model understandable to others.

Math modeling obliterates the question "Why do I need math?" by demonstrating the value and importance of math in approaching big problems found in our communities, regions, and world. Identifying the important variables and quantifying them—even with assumptions and incomplete information—can lead students to insights and understanding that have reason and structure.

"We always give a line of reasoning behind our equations and how we derive them. So I think reasoning is really important because if you can support your model, it increases the validity of your model."

Joy Qu, member of a 2021 finalist team from Adlai Stevenson High School in Lincolnshire, Illinois, U.S., when asked about the secret to the team's success.

Join the growing community of math modelers.

MathWorks Math Modeling Challenge (M3 Challenge), a program of Society for Industrial and Applied Mathematics (SIAM), is a free online contest for high school juniors and seniors and sixth form students. Teams of 3–5 students solve an open-ended problem about a real issue in 14 continuous hours over Challenge weekend. Past competition topics include issues such as the transition of trucking from diesel to electric, universal internet access, substance abuse, food insecurity, plastic recycling, and car sharing. The use of online collaboration tools and resources is encouraged.

Scholarships totaling $100,000+ (£75,000+) will be awarded in 2023. Extra credit awards are available for teams who choose to write or employ outstanding code as part of their solution. The competition has given over $1.75 million to date.

For rules, resources, and to register visit M3Challenge.siam.org.

Register by February 24, 2023
Challenge weekend is March 3–6, 2023 (Friday through Monday)

M3 MathWorks Math Modeling Challenge
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