# Lessons 13 & 14: Mathematical Modeling[1]

## PREPARATION

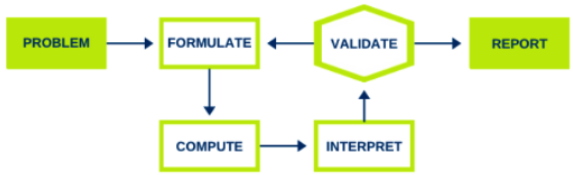
| Lesson Goals | Learning Targets |
|---|---|
| • Understand the meaning of a modeling prompt.<br>• Understand expectations of a student response to a modeling prompt. | • I can describe what a modeling prompt is.<br>• I can explain some elements of a good response to a modeling prompt. |

### Lesson Narrative

Modeling is the link between the mathematics students learn in school and the problems they will face in college, career, and life. Time spent on modeling is crucial, as it prepares students to use math to handle technical subjects in their further studies, and problem solve and make decisions that adults regularly encounter in their lives.

In addition to micro-modeling opportunities on the Checkpoint Lesson days, there will be four scheduled modeling blocks (two lessons each) over the course of Math 1. Lessons 13 & 14 are the first of those four. In each of the blocks, there will be teacher choice around which modeling prompt(s) to offer and which version of the prompt(s) students will receive. Many prompts offer different versions that provide varying levels of complexity. However, it is highly recommended to begin with Modeling Prompt #1, which provides students a scaffolded way to learn about modeling by evaluating a sample response to a prompt. If time permits, Modeling Prompt #2 is also offered in which students either name a question that requires them to gather and analyze data to answer or are given a data set to work with.

Students most likely will have had little opportunity to do much modeling prior to Math 1, so taking time to support the ideas around the modeling cycle is important. Students may be surprised to be presented with a problem where they need to make assumptions or that there are multiple "correct" responses.




**Things the Modeler Does When Modeling with Mathematics (NGA 2010)**

1. *Pose a problem* that can be explored with quantitative methods. Identify variables in the situation and select those that represent essential features.
2. *Formulate a model*: Create and select geometric, graphical, tabular, algebraic, or statistical representations that describe relationships between variables.
3. *Compute*: Analyze these relationships and perform computations to draw conclusions.
4. *Interpret* the conclusions in terms of the original situation.
5. *Validate* the conclusions by comparing them with the situation. Iterate if necessary to improve the model.
6. *Report* the conclusions and the reasoning behind them.

It's important to recognize that in practice, these actions don't often happen in a nice, neat order.



### Modeling Prompt #2: Display Your Data

In this modeling prompt, students will work on displaying a data set that answers a particular question. There are two versions of this prompt: 2A and 2B. In 2A, students determine the question they are interested in learning about, find the necessary data, and display their results. In 2B, students are given data to use, determine a question that can be answered with the data, and display their results. Determine, in advance, which Modeling Prompt (2A or 2B) students will receive, based on the lift-analysis, timing, and access to data.

**Student Task Statement 2A Lift Analysis**

| Attribute | DQ | QI | SD | AD | M | Avg |
|---|---|---|---|---|---|---|
| Lift | 2 | 2 | 2 | 2 | 1 | 1.8 |

**Student Task Statement 2B Lift Analysis**

| Attribute | DQ | QI | SD | AD | M | Avg |
|---|---|---|---|---|---|---|
| Lift | 2 | 2 | 2 | 1 | 1 | 1.6 |

**Step 1 (optional step- review materials as necessary)**

- Display and pass out the Advice on Modeling and Modeling Rubric handouts.
- Facilitate a discussion around modeling. Share some of the following ideas:
  - Modeling prompts are often expressed in words, but unlike word problems, modeling prompts challenge the modeler to make reasonable assumptions, decide what information is important, ask or research for more information if needed, think creatively within constraints, and consider the implications of the model.
  - The process of modeling is cyclical, and it does not end by producing a "correct answer."
  - A mathematical model expresses a simplified relationship in the real world; models can be rough but still useful.
  - Models can often be refined to represent the real-world relationship more accurately.
  - Responses to modeling prompts can vary widely, but they often contain certain pieces: assumptions, calculations, a mathematical model (stated with an equation or equations, with a graph, with a geometric diagram, or in words), conclusions, and generalizations.
- Provide time for students to ask clarifying questions. Students should have a good-enough understanding of the rubric, however, deep understanding of the rubric is not needed at this time.

**Step 2**

- Pass out the pre-determined appropriate blackline master Modeling Prompt #2 (2A or 2B).
- Students can be arranged in groups in advance, they can choose groups based on the questions they are most interested in, or use visibly random grouping.
- **Modeling Prompt 2A**
  - Ask students to think about a question they are interested in for which they would need to gather data in order to answer.
  - Students will choose one of these questions, find data relevant to it, and present their results with a data display or an infographic. If needed, show students examples of infographics or ask them to look up a few examples.
- **Modeling Prompt 2B**
  - Give students a source of data and let them explore it for a few minutes. Have them share observations with their classmates. This task can be further scaffolded by giving students data sources that are easier to work with.
  - Students will brainstorm some questions that could be answered with the given data.
  - They will then choose one of these questions, find data relevant to it, and present their results with a data display or an infographic. If needed, show students examples of infographics or ask them to look up a few examples.

**RESPONSIVE STRATEGY**

If students are not sure where to begin, it might be helpful for them to think about questions that compare two groups, since they have been doing a lot of work with comparing data sets using measures of center and variability, and this is the kind of data analysis they will be expected to do. For example, in states that have sales tax on food do people have less food security than states with no sales tax on food?