

TOPIC 2

Math Modeling in 3 Acts: Parallel Paving Company



Lesson Overview

Mathematics Objectives

- ✓ Use mathematical modeling to represent a problem situation and to propose a solution.
- ✓ Test and verify the appropriateness of their math models.
- ✓ Explain why the results from their mathematical models might not align exactly with the problem situation.

Language Objective

- ✓ Describe and solve a problem involving parallel and perpendicular lines using appropriate terms.

Essential Understanding

Many real-world problem situations can be represented with a mathematical model, but that model might not represent the real-world situation exactly.

Earlier in this topic, students:

- Explored parallel and perpendicular lines.

In this lesson, students:

- Develop a mathematical model to represent and propose a solution to a problem situation involving parallel and perpendicular lines.

Later in this course, students will:

- Refine their mathematical modeling skills.

This mathematical modeling lesson focuses on application of both math content and math processes.

- Students draw on their understanding of concepts related to parallel and perpendicular lines to develop a representative model.
- Students apply their mathematical model to test and validate its applicability to similar problem situations.



Math Modeling in 3 Acts is Powered by Desmos.

MATH
MODELING
IN 3 ACTS

Mathematical Process
Standards
G.1A Apply mathematics to
problems arising in everyday
life, society, and the workplace.
TEKS
G.2B, G.2C

Parallel Paving Company

Building roads consists of many different tasks. Once civil engineers have designed the road, they work with surveyors and construction crews to clear and level the land. Sometimes specialists have to blast away rock in order to clear the land. Once the land is leveled, the crews bring in asphalt pavers to smooth out the hot asphalt.
Sometimes construction crews will start work at both ends of the new road and meet in the middle. Think about this during the Math Modeling in 3 Acts lesson.

ACT 1 Identify the Problem

1. What is the first question that comes to mind after watching the video?
2. Write down the main question you will answer about what you saw in the video.
3. Make an initial conjecture that answers this main question.
4. Explain how you arrived at your conjecture.
5. What information will be useful to know to answer the main question? How can you get it? How will you use that information?

ACT 2 Develop a Model

6. Use the math that you have learned in this Topic to refine your conjecture.

ACT 3 Interpret the Results

7. Did your refined conjecture match the actual answer exactly? If not, what might explain the difference?

BUILD G.R.I.T. Resilience

If you need help, be open to ideas from your classmates. There are multiple ways to model the roads, and to draw conclusions.

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Student Companion

Students can do their work for the task on their *Student Companion* pages, which you can print from [SavvasRealize.com](https://www.savvasrealize.com).

Texas Essential Knowledge and Skills (TEKS)

Mathematical Process Standards

The student uses mathematical processes to acquire and demonstrate mathematical understanding. The student is expected to:

G.1A apply mathematics to problems arising in everyday life, society, and the workplace

Coordinate and transformational geometry. The student uses the process skills to understand the connections between algebra and geometry and uses the one- and two-dimensional coordinate systems to verify geometric conjectures. The student is expected to:

G.2B derive and use the distance, slope, and midpoint formulas to verify geometric relationships, including congruence of segments and parallelism or perpendicularity of pairs of lines. **Also G.2C**



Parallel Paving Company

In this mathematical modeling task, students will explore and apply concepts related to parallel and perpendicular lines. Students will analyze a situation involving paving pairs of roads with certain conditions. They will be tasked with determining whether pairs of lines are parallel, perpendicular, or neither. To do so, they apply concepts they study in Topic 2.

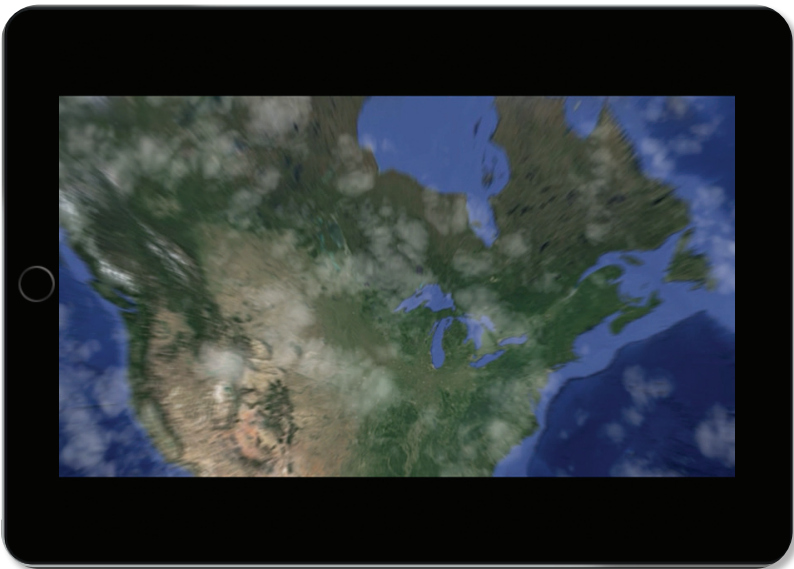
ACT 1
The Hook

Play the video. The video shows a paving company building roads on undeveloped land. We see the first few days’ progress at each of the three sites.

After the question brainstorming, present to students the Main Question they will be tasked with answering. Remind students to write down their questions and conjectures.

MAIN QUESTION

Are these roads paved correctly? Are they really parallel or perpendicular?



ACT 2
Modeling With Math

Think about the task. Ask students to speculate how they can determine whether the lines are being paved correctly. Then have them think about what information they need.

Reveal the information. Use the tool, which overlays a coordinate grid on each site. Rather than provide students with coordinates for each road, encourage them to use the coordinate grids to find the information they need. Sample points, using the middle of each road, are provided at the right.

Students may not yet realize that the Day numbers in the video are not relevant to the Main Question.

What’s the connection? Give students time to struggle as they think about how to connect their ideas to what they learned in this topic about parallel and perpendicular lines. Ask how they can use the information from the coordinate grids to answer the Main Question for each site.

INTERESTING MOMENTS WITH STUDENTS

Discuss with students what “paved correctly” means for each site. For the first site, it means that the roads should be parallel. For the second site, the roads should be perpendicular cross streets. The third site is one road, started from opposite ends, so it should meet in the middle.

Ask students for more points. If they’re stuck, ask students to write down a third and fourth point on each line. Ask them to justify their responses, which may lead to a necessary discussion of slope.

Necessary Information

Sample Points

Site 1

Road 1 passes through (2, 1) and (5, 2).
 Road 2 passes through (4, 9) and (11, 11).

Site 2

Road 1 passes through (5, 4) and (12, 5).
 Road 2 passes through (13, 9) and (14, 2).

Site 3

Road 1 passes through (0, 8) and (4, 9).
 Road 2 passes through (16, 13) and (20, 14).

The roads are straight and flat.
 There are no obstacles in the way that would prevent the roads from continuing straight.



ACT 3 The Solution

Play the video. The final video shows the completion of each of the three construction sites. It is revealed whether each road is paved correctly. Offer praise to the students whose conjectures are correct.

MAIN QUESTION ANSWER

Site 1: The roads are not parallel.

Site 2: The roads are perpendicular.

Site 3: The roads are parallel, and they will not meet.

Do the “post-game” analysis. Engage students in a discussion about possible reasons why the equations they wrote would not be perfect models for the paths of roads. The construction site may not be perfectly flat. It may be preferable to build a road around trees than to cut them down.

Now that the solution has been revealed and discussed, ask students to analyze and evaluate the efficiency of the approach they chose to solve the problem.

ONE POSSIBLE SOLUTION

The first pair of roads have slopes $\frac{2}{7}$ and $\frac{1}{3}$. They look nearly parallel but they are not. The paving company is paving the roads incorrectly.

The second pair of roads have slopes $\frac{1}{7}$ and -7 . They are perpendicular. The paving company is paving the roads correctly.

The third set of roads both have slope $\frac{1}{4}$, so they are parallel. However, the equations for the third set of roads are $y = \frac{1}{4}x + 8$ and $y = \frac{1}{4}x + 9$, so they won’t meet in the middle. The paving company is paving the roads incorrectly.

INTERESTING MOMENTS WITH STUDENTS

Roads have thickness that lines do not. Students may use the top edge of the roads, the middle line, or some other guide. Help them realize that the part they use affects the equations of the lines but does not affect the answer.

CREATE A PROBLEM

As students finish, ask them to create a problem with their own road design: a pair of roads that is perpendicular, another that is parallel, and a third that is neither parallel nor perpendicular. Have students trade problems with a partner and prove, without drawing, that each pair of roads meets the required condition. [Answers will vary. Check students’ work.]

