Mathematical Modeling: Spies and Analysts™

Spies

In real life, it's not always clear what information you'll need to solve a problem or how you would even get that information. For example, if you needed a formula to figure out how much to charge customers of a ride-sharing app, what information would you use?

- Would you look at how far the driver has to go?
- Does traffic or driver experience matter?
- Does the type of car, city, or number of passengers matter?
- Should it cost less when demand is low and more when demand is high?

The list of questions could go on and on. This is where the Spies come in. Spies have to figure out what information is needed and acquire it. This involves thinking about what information is already provided, what information is needed to solve the problem, and sometimes what other information can be used if their first choice is unavailable.

Analysts

This information is passed on to the Analysts, who decide what is important and use it to create a mathematical model (*often a formula, algorithm, or other mathematical representation of the situation*). This can be challenging because even if you had all the information you wanted, how would you take all those factors and turn them into a formula that generated a competitive price? That formula would be your mathematical model.

Mathematical Model

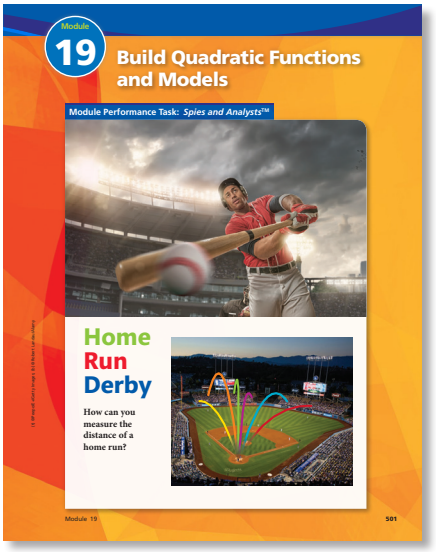
Once the Spies and Analysts are done acquiring the information and putting it together, they still have to determine whether the mathematical model they came up with was any good. For example, if people open the ride-sharing app to check for the price but don't actually take a ride, it could be a sign that the mathematical model is not doing its job. This likely leads to a process of never-ending refinement.

Spies and Analysts in Action

Overview

This problem requires students to make assumptions to determine the distance of a home run. Examples of assumptions:

- The information from the cameras will show the highest point of the baseball.
- Home plate is represented by (0, 0).
- The city you're in does or doesn't matter.



Be a Spy

First, students must determine what information is necessary to know. This should include:

- The vertex of the baseball's path
- A second point on the baseball's path

Be an Analyst

Students may assume that they will find the distance that the ball was hit into the stands. If they make this assumption, ask them what the solutions of a quadratic equation represent. Students should realize that they will find the distance between the points at which $f(x) = 0$. The first point is where the baseball starts at home plate and the second point is where the baseball is projected to land on the ground.

Alternative Approaches and Mathematical Models

In their analysis, students might:

- Use the algebraic methods to write a quadratic equation
- Draw a parabola to estimate to the distance of the home run
- Use a graphing calculator to find the solutions using the vertex and another point on the graph

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