

Threat Assessment

A Develop Understanding Task

Purpose: To determine the placement of an Active Vehicle Barrier on Kirtland Military Base.

Career Field: Civil Engineering

StanTec

WTCC Associate Program of Study and Contact Person:

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NC Math 4 Standards:

NC.M4.AF.1.2 Execute a procedure to determine the value of a composite function at a given value when the functions are in algebraic, graphical, or tabular representations.

Unit Alignment:

Indicate where this lesson would be used in the course

NC Math 4 - Unit

WTCC Math 121, 171

Common Core State Standards for Mathematical Practice

Indicate which of the standards are highlighted in this lesson

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.
5. Use appropriate tools strategically.

Prerequisite Skills

List any prerequisite skills that may need to be addressed in a warm-up

- Unit Conversions
- Evaluating Functions
- Use of Excel
- Solving Literal Equations

Time Required

The time required to complete this activity is approximately 120 minutes.

Materials Needed

- Student Activity Sheet
- Access to Excel

The Teaching Cycle:

Launch:

Assign the Desmos Launch activity for homework the night before. Alternatively, the Desmos Launch activity could be provided at the end of one class and the Explore part could be completed the next day in class.

The launch of this activity will review the following topics, unit conversion, solving literal equations, and evaluating functions. In addition, students will learn or review how to use Goal Seek in Excel and how to use excel as a calculator. Students will also be introduced to the idea of referring to distance as stations, where station $3+25$ is 325 feet. These topics are included in the Desmos Launch for this activity. In addition, there is a launch video which is included as part of the Desmos Launch but is also linked here.

Explore 1:

Students will work in groups of 2-3. They will complete the attached student activity sheet. The teacher will facilitate this activity by monitoring student participation. In an online course, the teacher can choose to schedule check-ins with the group to monitor progress.

Activity Background Information:

All military bases have a system in place to deal with unauthorized vehicles that attempt to force entry onto the base. Stantec is working to make sure that the active vehicle barriers (AVB) is placed in a location where it will catch all possible types of unauthorized entry while keeping everyone on the base safe.

Initial thought questions:

Students will first spend some time thinking about these safety measures, where the AVB should go and why as well as other considerations for placement of the barrier. For the initial thought questions, look for students to provide answers such as: safety, cost, or space. There will be a variety of answers to where the AVB should go. The main goal is for students to provide a reason for their placement.

Sequence of events:

After the initial thought questions, students will move into the problem. They will first understand the sequence of events that need to happen in order for the AVB to have the proper placement. During this part of the activity, students will provide the minimum time required which should be 9 seconds, consider why there is a difference in guard reaction time for the first three threats versus the last threat, discuss why these three things must happen in sequence, and think of some reasons why bases would want more than 9 seconds to deploy the AVB? Students will provide a variety of answers for these. Below are some possible answers to questions 2-4.

Threat 4, the guard expects everything to be going fine because he turned away the unauthorized vehicle. It's not until the vehicle reaches the turn around spot and does not turn around that the guard realizes something is wrong. Therefore, it might take him longer to realize there is a problem. The first three threats become clear to the guard faster that the vehicle is going to attempt to enter when they shouldn't.

It is not possible for the three things to happen together. The guard has to realize there is a problem in order to alert the rest of the base. There also has to be a waiting time so that others on the road on the base can safely pull over so as not to run into the Active Vehicle Barrier.

A military base might increase the time if they have guards with slow reaction time, if they want to give a longer barrier safety system, or if their AVB takes longer than 4 seconds to deploy.

Students will be presented with an image of Kirtland Military Base and asked why curves in the road would involve additional calculations. Hopefully, the students will realize that perhaps they will only be able to go so fast and so far without skidding out and ending up wrecking their vehicle.

Before getting into the work for the activity, students are asked to consider why the max velocity is 130 mph, research super elevation and explain what it is, and explain why assuming a super elevation of 0% provides a more conservative result? Sample answers may include, most cars have speedometers that only go as high as 140 mph to 160 mph, super elevation is the tilt of a road and it will keep skidding speed lower and keep the speed safer.

Discuss 1:

At this point, you can bring the class together and ask the different groups to share their responses and reasons. You could even post a large picture of the base and have each group mark their predicted placement of the AVB. Then after the activity do it again and see who is closest.

Explore 2:

Continuing to work in groups, students will develop a spreadsheet in Excel and use goal seek to determine how far the car travels in 9 seconds for threat 2. The questions relating to this threat will both ask students to think about their answers and what is happening as well as provide them some scaffolding as they work through this activity. After determining the distance that the threat 2 vehicle travels, they will mark the location of the vehicle on the map on the last page. Then they will go on to determine the location of the threat 3 vehicle and threat 4 vehicle in a manner similar to threat 2. The location of these vehicles will also be placed on the map on the last page.

The final threat is threat 1. Students will first contemplate the differences in this threat versus the first three and discuss how the differences might affect our calculations. Because of the additional steps and calculations, students will be walked through this activity as well as they find the location of vehicle 1. Vehicle 1 takes 3 segments of road in order to reach the 9 second mark. The first two are in the curve and the last one is on the tangent. After this problem, the students should mark the location of vehicle 1 on the map on the last page.

The AVB should go wherever the car that makes it furthest is.

Discuss 2:

Ask students to share their distances. They should all be very close to each other, even the same perhaps. If they are wildly different, ask students to explain how they reached their answer. Ask students which vehicle makes it furthest and where they decided to place the AVB. You could have students come back to the large printout of the base and have them identify the location of the AVB after their calculations. Ask them to reflect on their initial placement versus final placement. Were they close? What things did they not consider when making their original placement?

Exit Ticket:

As students prepare to leave, ask them to reflect on their learning. What did they learn today? Do they have any lingering questions?

Two example assessments for testing:

[Student Activity Sheet](#)

Answer Key