INITIATE Lesson Plan: *Accelerating in a Smart Car*

Lesson plan at a glance...

Name:	Accelerating in a Smart Car
Course:	Algebra 1 Honors
Grade Level:	8-9
Prerequisites:	*Students will need to know how to create scatterplots, classify tables and graphs as linear, exponential or quadratic, and write linear, exponential and quadratic equations.*
Time:	**Preparation: 10 mins** **Instruction:** 2 class periods
Standard(s):	F-LE 1 a., F-LE 2., F-LE 3.

In this lesson plan…

- Lesson Overview
- Driving Questions
- Materials and Equipment
- Preparation Tasks
- The Lesson
- Learning Objectives and Standards
- Additional Information and Resources

Lesson Overview

In this lesson students will measure the distances traveled by the smart car at various percentages of speed. Students will graph the results and classify each scenario as linear, exponential or quadratic. Students will write equations for each scenario and use their equations to make predictions.

Driving Questions

Overarching Driving Questions for Bowsher Wide Project:

- How can we make smart cars safer and more convenient?
- How can we protect them from cyberattacks?

Lesson Specific Question: Why are different acceleration programs needed in a smart car?

Materials and Equipment

Smart cars and tablets
Flexible measuring tapes
Calculators
Activity handout for each student (attached at bottom of lesson plan)

Preparation Tasks

	Copy activity handout for each student Be sure smart cars are charged and ready to go	10 mins

The Lesson

Warm-up Activity: *Thinking about car acceleration*	10 mins
Activity 1: *Acceleration Program 1*	15 mins
Activity 2: *Acceleration Program 2*	20 mins
Activity 3: *Acceleration Program 3*	20 mins
Wrap-up Activity: *Writing Acceleration Programs*	20 mins

Warm-up Activity: Thinking about car acceleration (10 mins)

Activity Overview: In this activity, students will discuss the lesson specific question of Why are different acceleration programs needed in a smart car?

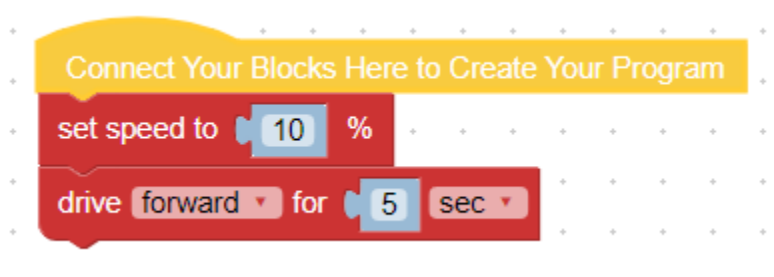
Activity: Students will watch three videos. The first video shows a car driving through a neighborhood, stopping at stop signs and stop lights, slowly accelerating between stops. Acceleration Video 1
The second video shows a car accelerating as it enters a freeway. Acceleration Video 2
The third video shows a car accelerating on a drag strip. Acceleration Video 3
After viewing the three videos, have a class discussion about the acceleration they saw in the three videos. Some possible questions to guide the class discussion follow.
What would happen if there was only one program for acceleration in a smart car? What if you slowly accelerated as you enter a freeway? What happens if you "gun it" at a neighborhood stop sign?

Activity 1: Acceleration Program 1 (15 mins)

Activity Overview: In this activity, students will explore the first acceleration program by running a simple program, collecting data, creating graphs, analyzing graphs, writing equations, and make predictions using their equations.

Activity: Students will use Bloxter to create a simple code to have the cars drive for 5 seconds at speed percentages of 10%, 20%, 30%, 40%, and 50% and record data in the table. Students will create two graphs, trial number vs. speed percentage and trial number vs. distance traveled. Students will classify the acceleration program as linear, exponential, or quadratic, then write two equations, one to relate trial number and speed percentage, and one to relate trial number and distance traveled. Students will use the equations they wrote to predict both speed percentage and distance traveled on the 9th trial.

Sample Bloxter Program (used for Activities 1, 2, 3)



Teaching Tips:

- *Be sure students are measuring to the same point on the car each trial.*
- *Be sure students are measuring in cm.*
- *Discussion may be needed as to why the data collected in not perfectly linear.*

Activity 2: Acceleration Program 2 (20 mins)

Activity Overview: In this activity, students will explore the second acceleration program by running a simple program, collecting data, creating graphs, analyzing graphs, writing equations, and make predictions using their equations.

Activity: Students will use Bloxter to create a simple code to have the cars drive for 5 seconds at speed percentages of

10%, 20%, 40%, and 80% and record data in the table. Students will use the collected data to predict the distance traveled if they could set the speed to 160%. Students will create two graphs, trial number vs. speed percentage and trial number vs. distance traveled. Students will classify the acceleration program as linear, exponential, or quadratic, then write two equations, one to relate trial number and speed percentage, and one to relate trial number and distance traveled. Students will use the equations they wrote to predict both speed percentage and distance traveled on the 9th trial.

Teaching Tips:

- *The smart cars do not go very straight at 80%, students may need help measuring along the curve.*
- *Discussion may be needed as to why the data collected is not perfectly exponential.*
- *Students may need help finding the common multiplier, as it will most likely be a decimal, not a whole number like they are used to.*

Activity 3: Acceleration Program 3 (20 mins)

Activity Overview: In this activity, students will explore the third acceleration program by running a simple program, collecting data, creating graphs, analyzing graphs, writing equations, and make predictions using their equations.

Activity: Students will use Bloxter to create a simple code to have the cars drive for 5 seconds at speed percentages of 10%, 20%, 40%, and 70% and record data in the table. Students will use the collected data to predict the distance traveled if they could set the speed to 110%. Students will create two graphs, trial number vs. speed percentage and trial number vs. distance traveled. Students will classify the acceleration program as linear, exponential, or quadratic, then write two equations, one to relate trial number and speed percentage, and one to relate trial number and distance traveled. Students will use the equations they wrote to predict both speed percentage and distance traveled on the 9th trial.

Teaching Tips:

- *Even at 70%, the car sometimes has a tendency to veer to one side or the other. Be aware of this.*
- *Discussion may be needed as to why the data collected is not perfectly quadratic.*
- *Students may need help finding the pattern, including the second difference.*
- *Students may need additional help in writing the equation as the process is more involved with quadratic equations.*

Wrap-up Activity: Writing Acceleration Programs (20 minutes)

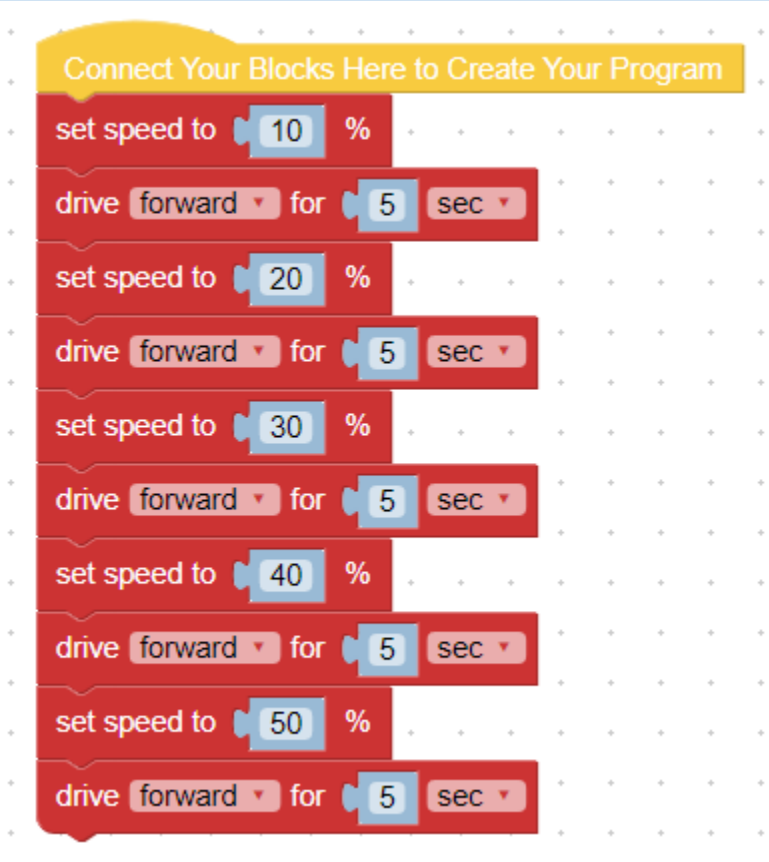
Activity Overview: In this activity, students will revisit the lesson specific question regarding the need for various acceleration programs in a smart car. Students will then create each acceleration program as a single Bloxter program.

Activity: Class discussion – Return to the lesson specific question and determine which program would be best if a person needed to merge on to a freeway with a semi-truck approaching. (program 2) Which program be most appropriate for accelerating after stopping at a stop sign in a neighborhood? (program 1) Give an example of a situation in which the third acceleration program would be most appropriate. (accelerating after a stop light on the Anthony Wayne Trail) Do you think all situations in which the car needs to accelerate could be

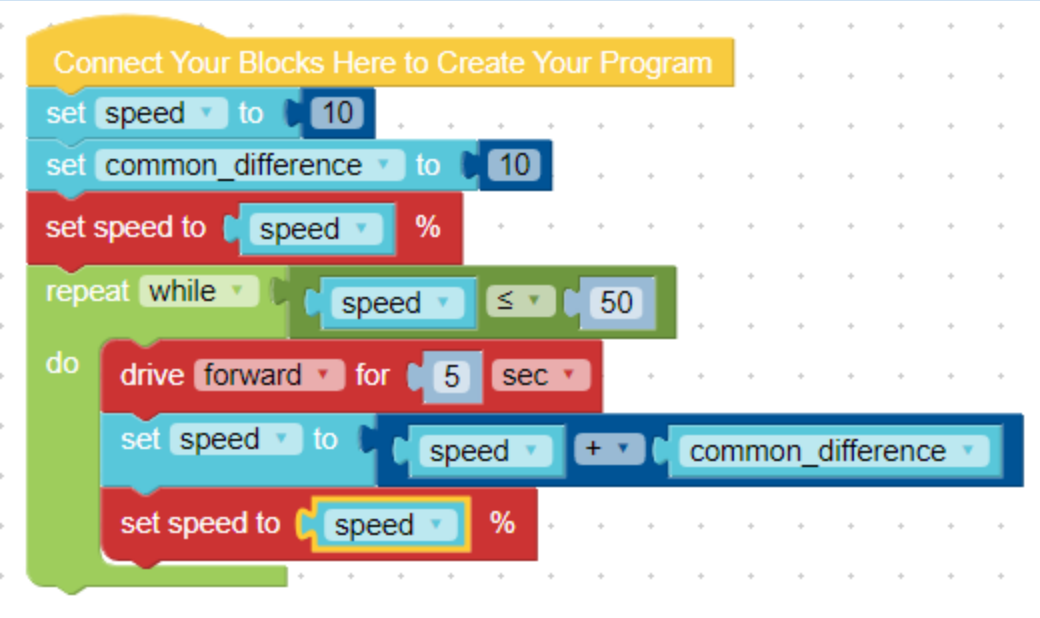
met with just these three acceleration programs? Or would others be needed? If others are needed, what situations would warrant a different program, and how would that program need to work? (solicit responses from students)

More advanced coding in Bloxter – Have students try to link together several commands in Bloxter to create acceleration program number 1. Run the smart cars using this acceleration program. Repeat the process for the second and third acceleration program.

Sample Bloxter Program:



After students are able to create this slightly more advanced Bloxter program and run it, the following program will be built with the students using loops discussing what each line in the code means. This new code will do the same thing as the code they just wrote in the wrap up activity for acceleration program 1.



After students see this code, discuss what changes would need to be made to write a program like this, using loops to represent acceleration program 2.

Assessment: Informal assessment would be ongoing throughout the lesson. Students would be assessed as they collect data, analyze the data, write equations, and make predictions.

Learning Objectives and Standards

Learning Objectives	Standards
Classify tables and graphs as linear, exponential, or quadratic.	F-LE 1. Distinguish between situation that can be modeled with linear functions and with exponential functions. a. Prove that linear functions grow by a constant difference over equal intervals and that exponential functions grow by equal factors over equal intervals.
Write equations for linear, exponential and quadratic tables and graphs	F-LE 2. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs (including reading these from a table).
Observe that exponential functions grow the quickest	F-LE 3. Observe using graphs and tables that a quantity increasing exponentially eventually exceeds a quantity growing linearly, quadratically, or (more generally) as a polynomial function.

Additional Information and Resources

Project-based Learning Features

Feature	Where does this occur in the lesson?
Making Sense of Data and Technology	In Activity 1, 2, and 3 students collect data, graph it on a coordinate plane, and interpret the type of relationship that exists. Students also use technology in these three activities.

Incorporation	
Driving Question	During the warm up students brainstorm why a smart car would need multiple programs for car acceleration. During the Wrap-Up, students revisit this idea.
Computational Thinking	Throughout the lesson students are involved in pattern recognition and algorithm creation.
Collaborative Opportunities	Students will work in groups during Activities 1, 2, and 3.

Computational Thinking Concepts

Concept	Where does this occur in the lesson?
Pattern Recognition	In Activity 1, 2, and 3 students will have to look for patterns in how far the car traveled in 5 seconds at various speed percentages.
Algorithm Creation	Students will form simple algorithms in Activities 1, 2, and 3 to have the car drive 5 seconds at various speed percentages. Students will also be creating equations to represent the various scenarios. During the Wrap-Up students will try to create a more complicated Bloxter programs to display continuous acceleration.

Administrative Details

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Sources: Ohio Content Standards YouTube Bloxter

Date Written: June 2018

Template adapted from: https://edu.google.com/resources/programs/exploring-computational-thinking/

Accelerating in a Smart Car

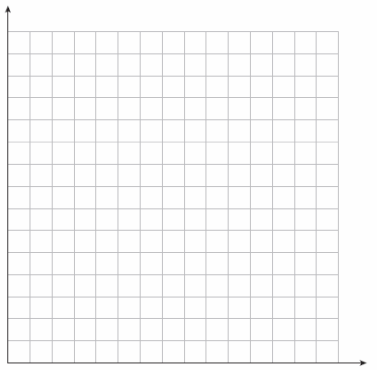
Activity 1: Acceleration Program 1

For each trial, set the correct speed percentage, run the smart car for 5 seconds, and record the distance traveled. Continue the pattern to determine the speed percentage for trial 5.

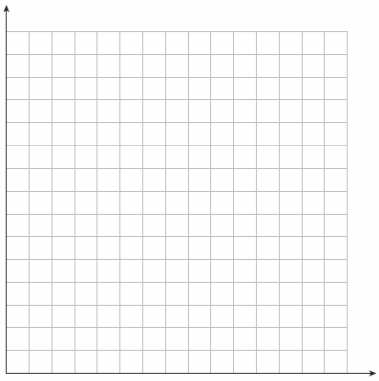
Trial	Speed Percentage
1	10%
2	20%
3	30%
4	40%
5	

Trial	Distance Traveled in 5 Seconds (cm)
1	
2	
3	
4	
5	

Create a graph for each of the tables above



Trial



Trial

Classify this acceleration program as linear, exponential, or quadratic.

Create an equation to relate the trial number and the speed percentage. Show all work.

Create an equation to relate the trial number and the distance traveled in 5 seconds. Show all work.

Use your equations to predict the speed percentage AND the distance traveled for the 9th trial. Show work.

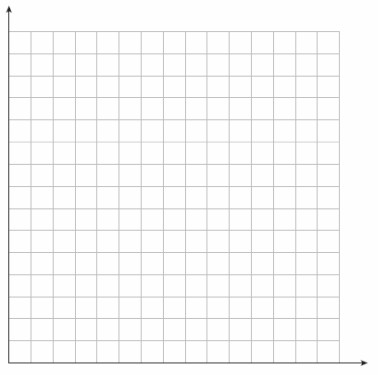
Activity 2: Acceleration Program 2

For each trial, set the correct speed percentage, run the smart car for 5 seconds, and record the distance traveled. Continue the pattern to determine the speed percentage for trial 5. DO NOT RUN TRIAL 5, instead use the pattern in the first 4 trials to predict the distance for trial 5.

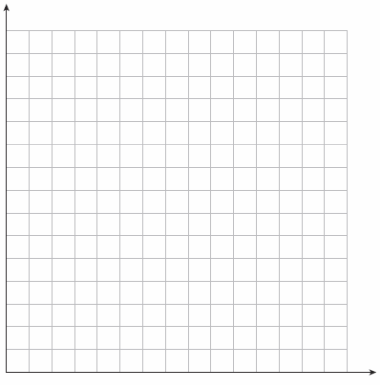
Trial	Speed Percentage
1	10%
2	20%
3	40%
4	80%
5	

Trial	Distance Traveled in 5 Seconds (cm)
1	
2	
3	
4	
5	

Create a graph for each of the tables above



Trial



Trial

Classify this acceleration program as linear, exponential, or quadratic.

Create an equation to relate the trial number and the speed percentage. Show all work.

Create an equation to relate the trial number and the distance traveled in 5 seconds. Show all work.

Use your equations to predict the speed percentage AND the distance traveled for the 9th trial. Show work.

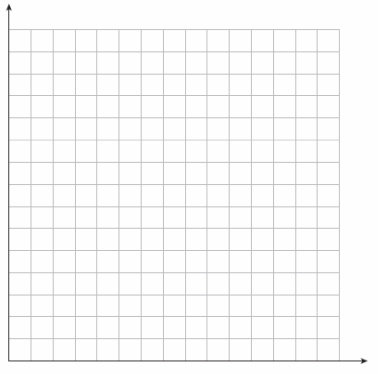
Activity 3: Acceleration Program 3

For each trial, set the correct speed percentage, run the smart car for 5 seconds, and record the distance traveled. Continue the pattern to determine the speed percentage for trial 5. DO NOT RUN TRIAL 5, instead use the pattern in the first 4 trials to predict the distance for trial 5.

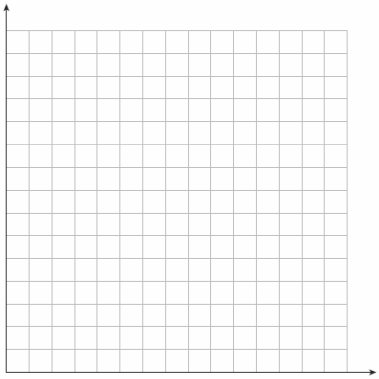
Trial	Speed Percentage
1	10%
2	20%
3	40%
4	70%
5	

Trial	Distance Traveled in 5 Seconds (cm)
1	
2	
3	
4	
5	

Create a graph for each of the tables above



Trial



Trial

Classify this acceleration program as linear, exponential, or quadratic.

Create an equation to relate the trial number and the speed percentage. Show all work.

Create an equation to relate the trial number and the distance traveled in 5 seconds. Show all work.

Use your equations to predict the speed percentage AND the distance traveled for the 9th trial. Show work.