Stop That Car!

Major Topic: Algebra Functions and Data Analysis

Length of Unit: 3 -90 minute classes

Unit Summary: Students will use their knowledge of linear, quadratic and exponential functions to find curves of best fit and make predictions about accidents given the stopping distances of vehicles in various situations. The unit also includes having a volunteer policeman to demonstrate a LiDOR to the students, and later use motion detectors themselves to apply real life connections.

Understanding Goals: Students will use their knowledge of quadratic functions to write an equation for the line of best fit, given a set of data points in a table, on a graph, or from a practical situation. They will also be able to make predictions about unknown outcomes, using the equation of a line of best fit. Students will be collecting data to make decisions and justify conclusions, as well as be able to describe errors inherent in extrapolation beyond the rage of the data.

Essential Questions:

- Describe the characteristics of a linear function, quadratic function, and exponential regression
- What role do domain and range play in this scenario?
- What role does the y- intercept play in this scenario?
- How do these characteristics relate to a real world application?

Student Objectives:

Students will be able to:

AFDA.3 collect data and generate an equation for the curve (linear, quadratic, exponential, and logarithmic) of best fit to model real-world problems or applications. Students will use the best fit equation to interpolate function values, make decisions, and justify conclusions with algebraic and/or graphical models.

Differentiation: Students will be working in collaborative groups so peer support will be available.

Lesson Contributed by: Bland Campbell
Funded through 2013 State Council of Higher Education for Virginia (SCHEV) grant, Creativity & Innovation in STEM (CI STEM)

Blooms Taxonomy	21st Century Skills
Creating Evaluating Analyzing Applying Remembering Understanding	Critical Thinking Problem Solving Collaboration Contextual Learning Communication

Performance Tasks:

Students will:

- find the regression for a given set of data
- collect, analyze and graph their data.
- work in groups of four. Each group will be given a crash scenario and will determine the speed of the car by measuring the skid marks. Each group will present their findings to the class.
- Question to think about:
    - What other factors could influence reaction, braking and stopping distances?
    - How do you think these factors might alter your regression models?
    - Extensions
    - Would the drivers be charged?
    - Could the accidents have been avoided? How?
    - What could the drivers be charged with? (speeding, reckless driving, etc)

Evidence of Formative Assessment:

- Discussions
- Group work

Evidence of Summative Assessment:

- Presentation
- Worksheet

Lesson Contributed by: Bland Campbell
Funded through 2013 State Council of Higher Education for Virginia (SCHEV) grant, Creativity & Innovation in STEM (CI STEM)

Technology

Hardware	Software
TI-84+ Graphing Calculators Internet Connection Computers Projection System	Multimedia TI – Smartview Web Browser

Resources from the web:

Search engines

Supplies:

- Graphing calculators
- Rulers
- Graph paper

Vocabulary: linear regression, quadratic regression, exponential regression, reaction distance, braking distance, stopping distance, skid mark, domain, range, maxima, minima, vertex , root, solution, zero, x-intercept, y-intercept, end behavior

Lesson 1: (1 -90 minute class)

- Students will describe the characteristics of linear, quadratic and exponential functions.
- Students will participate in a discussion with our police officer and watch a demonstration of the officer using LiDOR.

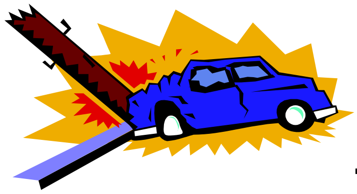
Lesson 2: (1 -90 minute class)

- Students will complete the worksheet, Crime Scene Investigation, in groups.
- Each group will be given a different crash scenario (not included) and will determine the speed of the car by measuring the skid marks.
- Each group work on a presentation their findings to the class.

Lesson 3: (1 -90 minute class)

- Students will make a presentation to the class.

Crime Scene Investigation



There is a lot that goes into stopping a car. No vehicle can "stop on a dime." How long it takes to stop depends on road conditions, the speed you are travelling, your perception/reaction time and the braking ability of your vehicle.

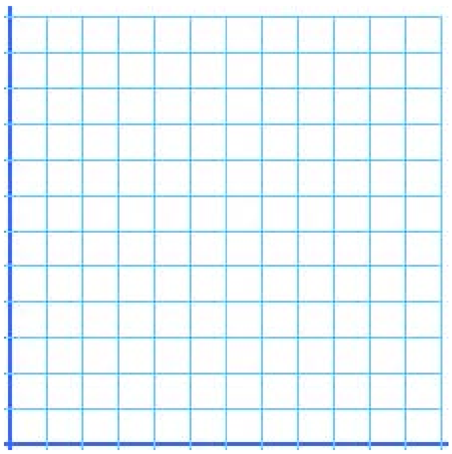
1. First you have to recognize that there's a problem up ahead and figure out what to do about it, (Should I brake? Should I steer left? Should I steer right?). Next you have to get your foot onto the brake pedal. That's *reaction time*. It only takes a tenth of a second.
2. Now you have your foot on the brake and your car is still moving. That's *braking distance*.
3. Then you have to get the car to stop. That's *stopping distance*.

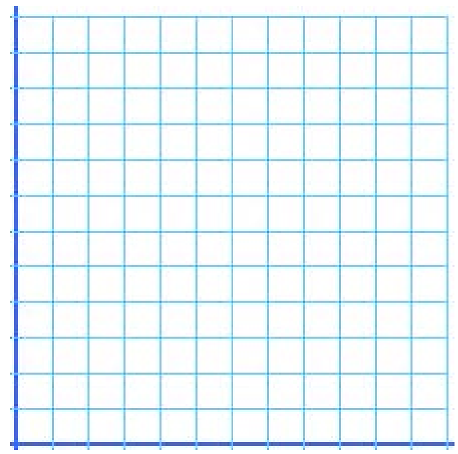
Complete the chart below and find the regression to model the relationship between speed and:

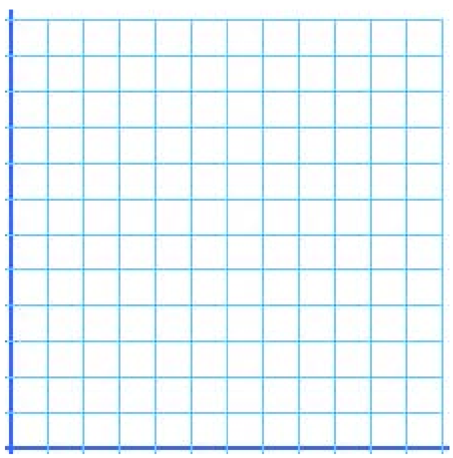
Speed MPH	Feet/ Second	Reaction Distance *	Braking Distance *	Stopping Distance*
20	29	44	19	63
30	44	66	43	109
40	59	88	76	164
50	73	110	119	229
55				
60				
65				
70				
75				

*Distances are in feet

1. Graph your results. Label your axes.







2. Regression models:
   a) Reaction distance

   b) Braking distance

   c) Stopping distance

3. Does there appear to be a relationship between the speed and:
   a) the reaction distance?

   b) the braking distance?

   c) the stopping distance?

4. When you examine the graphs of each regression, what are the y-intercepts?

   What is the real world meaning of the y-intercept?

5. Why did you choose the regressions for each distance?

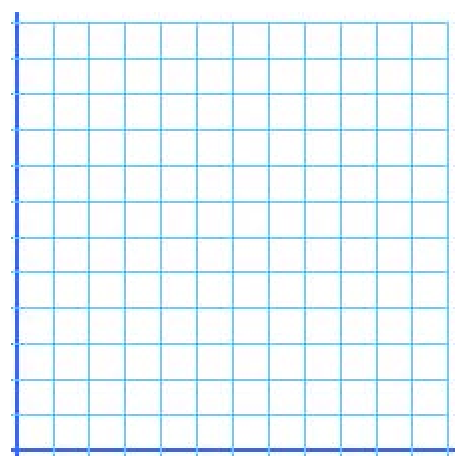
6. How would this information be useful in making predictions?

You will be given a crash scenario for your group to analyze. Be prepared to present your findings to the class. You will include:

A description of the accident.

The table that you used.

A graph of your data (label your axes)



The regressions used to model your data.

Describe how the road conditions changed the initial regressions.

How do you think your data would change if it was night time?

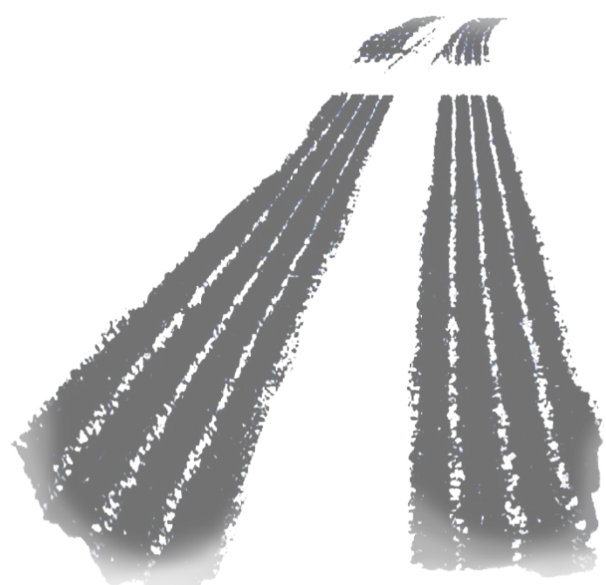
Do you think this accident could have been avoided? Why?

Sample Scenario

A skid mark is a tire mark on the road surface produced by a tire that is locked, that is not rotating. A skid mark typically appears very light at the beginning of the skid getting darker as the skid progresses and comes to an abrupt end if the vehicle stops at the end of the skid.

A skid mark is left when the driver applies the brakes hard; locking the wheels, but the car continues to slide along the road. Steering is not possible with the front wheels locked. Skid marks are generally straight. The skid speed is the speed of the vehicle at the beginning of the visible skid mark. Skid distances do not include perception-reaction time distances.

Speed MPH	Feet/ Second	Reaction Distance	Stopping Distance*			
			Dry	**Wet**	**Gravel**	**Snow**
20	29	44	63	68		
30	44	66	109	121	60	100
40	59	88	164	185	107	178
50	73	110	229	262	167	278
55					240	400
60						
65						
70						
75						



It was snowing. The scale for the skid mark is 23 ft/inch