

SATEC



This lesson was developed under a grant funded by the United States Department of Education, Office of Education Research and Improvement.



Lesson created by Andrew Sorensen

I. About the Math

A. Critical Mathematics Explored

The student will collect data using a light probe, analyze the data, and use the data to formulate a rational equation that best describes the situation. The student is also expected to make use of the equation to make predictions based on this model.

The lesson also investigates parameter changes for the function and requires the students to analyze the situation in order to provide reasonable solutions.

B. How Students Will Encounter Concepts.

Students are required to answer a series of questions that involve making predictions about the event. From these questions, the student is required to make a graphical representation of their prediction, and identify the parent function which best describes their graphical model.

Students will use the light probe in order to collect data of the intensity of the light of a hand held flashlight. With the aide of Graphical Analysis or a graphing calculator, the student will create a mathematical model that represents their collected data.

The student will be required to use the mathematical model to make reasonable predictions.

II. Setting Up

A. List of Materials.

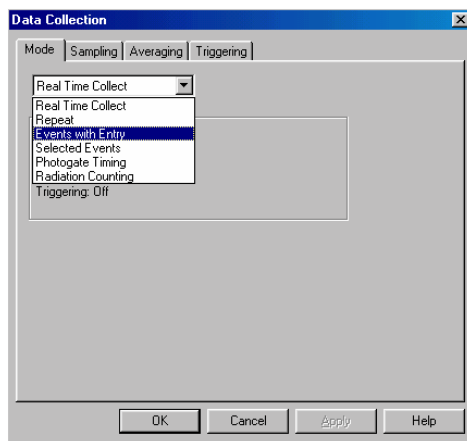
- A copy of the Student Activity per student.
- A hand-held Flashlight per computer station.
- A meter stick, or measuring tape.
- Light Probe connected to the ULI.

B. What the Teacher should do to Prepare.

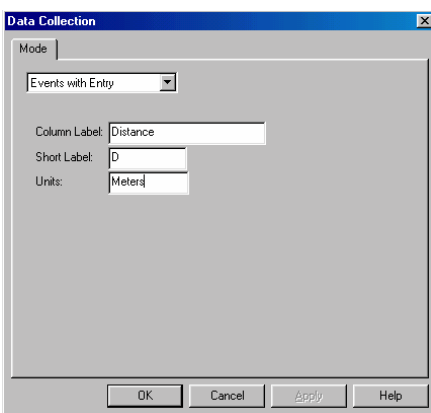
- *Make sure that the room is as dark as possible!!!*
- Make sure the Light probe is working properly and connected to the ULI. Be sure the setting is at 6000 Lux
- Make sure that a copy of the File Fade Away is created in the Light Sensor Folder inside Logger Probe's Experiment Folder.

***** In case there is no file called Fade Away, follow the steps to create one:**

1. **Open** the file called 6000 Lux inside the light sensor folder.
2. On the menu bar, **click** on *Setup* to get the following screen and make sure to choose **Events with entry**:



- Fill in the following information on the Data collection:



- Double-click on the title of the graph and change it to “*Light vs. Distance*”
- Save as “Light vs. Distance”

The Light probe has three different settings. We will use the highest settings for the data collection (6000 Lux). ***Be sure the light probe has that setting before you open the file!***

- C. Optional ways to set up the experiment.
- Tape the flashlight to the floor and tape the meter stick in front of it. You would then move the light probe at increments of 5cm.
 - Tape the light probe to the floor and tape the meter stick in front of it. You would then move the flashlight at increments of 5cm.
 - Hold the flashlight and light probes and measure between them.

III. Teacher Notes

a) Objective

The objective of this lesson is to revisit the concept of rational functions studied in the “In Perspective” Lesson. Concepts such as domain, range, dependent variable, and

independent variable are all reinforced. Students encounter an extension, $y = \frac{1}{x^2}$, of the situation they encountered in the survey lesson “In Perspective”. Identifying the parent function is still a major objective, as well as writing, and using the equation to make predictions that fit this model.

b) Teachable Moments

c) Connections

The student is expected to make connections to previous knowledge of the Rational Function and the basic shape of the parent function. Students will make connections with concepts of Domain and Range for the Rational Function.

d) Classroom Management Tips

The room must be as dark as possible. The light of the computers will give enough light to move around safely.

All the experiments should be lined up in the same direction so that no one’s light interferes with other flashlights.

e) Pre-requisites

Students should be familiar with Logger Pro and Graphical Analysis. They should know domain and range

f) Questions

Will the light intensity ever reach to zero?

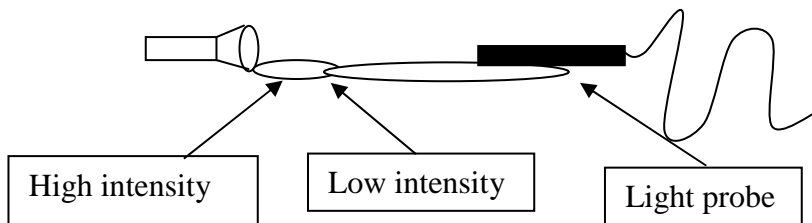
What happens to the light intensity as the light source is further away from the probe?

Can the light source ever be zero?

What happens to the light intensity as the light source is closer to the probe?

g) Supplementary Comments

- It is very important that the students are consistent in taking the measurements once the light reading is stable, and from the same position facing the sensor.
- To minimize error make sure you emphasize to the students to place the light source at the same angle and position always as this will impact the light intensity.
- It is a good idea to tape the light source to the floor or table as well as the tape measure to minimize errors.
- Students should collect data starting from the higher intensity point and not necessarily at front of the light. (SEE PICTURE).



Continue collecting data until 10-12 data points are collected. This will create a nice graph and emphasize the smaller change in the intensity over the distance. An *Automatic curve fit would not give you the best graph possible unless a Manual curve fit is performed.*

- The purpose of the box that says “Stop. Have you checked with your teacher?” is to assure that all students have a rational function. Initial the box so that you know they had the proper graphs.

h) Follow-ups/extensions

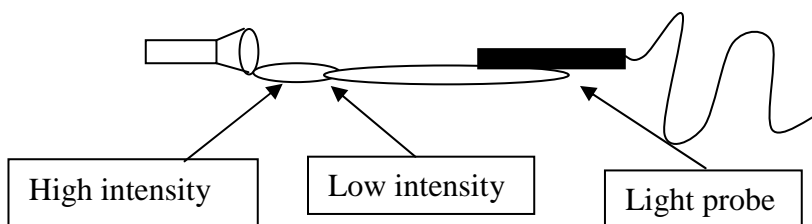
Use a laser pen to demonstrate the intensity of the laser compared to the intensity of a flashlight.

Use the laser pen to create a second line to create a point of intersection with the light intensity of the flashlight and that of the laser pen.

i) Answers

Answers will vary for this exercise, however the graph should be a rational function. Depending on the intensity of the flashlight, the initial Lux reading will vary.

Students should collect data starting from the higher intensity point and not necessarily at front of the light. (SEE PICTURE).



IV. TEKS

(a) Basic understandings.

- (3) Functions, equations, and their relationship. The study of functions, equations, and their relationship is central to all of mathematics. Students perceive functions and equations as means for analyzing and understanding a broad variety of relationships and as a useful tool for expressing generalizations.
- (5) Tools for algebraic thinking. Techniques for working with functions and equations are essential in understanding underlying relationships. Students use a variety of representations (concrete, numerical, algorithmic, graphical), tools, and technology, including, but not limited to, powerful and accessible hand-held calculators and computers with graphing capabilities and model mathematical situations to solve meaningful problems.
- (6) Underlying mathematical processes. Many processes underlie all content areas in mathematics. As they do mathematics, students continually use problem-solving, computation in problem-solving contexts, language and communication, connections within and outside mathematics, and reasoning, as well as multiple representations, applications and modeling, and justification and proof.

(b) Foundations for functions

- (1)** The student uses properties and attributes of functions and applies functions to problem situations.
 - (A)** For a variety of situations, the student identifies the mathematical domains and ranges and determines reasonable domain and range values for given situations.
 - (B)** In solving problems, the student collects data and records results, organizes the data, makes scatterplots, fits the curves to the appropriate parent function, interprets the results, and proceeds to model, predict, and make decisions and critical judgments.

(e) Rational functions

The student formulates equations and inequalities based on rational functions, uses a variety of methods to solve them, and analyzes the solutions in terms of the situation.

- (1)** The student uses quotients to describe the graphs of rational functions, describes limitations on the domains and ranges, and examines asymptotic behavior.
- (2)** The student analyzes various representations of rational functions with respect to problem situations.
- (3)** For given contexts, the student determines the reasonable domain and range values of rational functions, as well as interprets and determines the reasonableness of solutions to exponential and logarithmic equations and inequalities.
- (4)** The student solves rational equations and inequalities using graphs, tables, and algebraic methods.
- (5)** The student analyzes a situation modeled by an exponential function, formulates an equation or inequality, and solves the problem.



Student Activity

For this experiment, you will measure the intensity of light as the distance changes

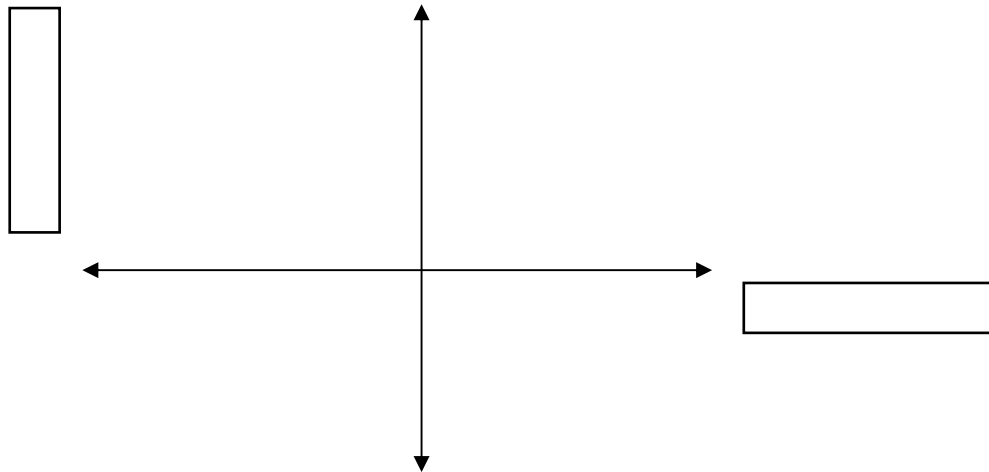
1. I identify the two variables for this experiment. _____

2. I identify which variable is the Dependent Variable, and explain your reasoning. _____

3. I identify which variable is the Independent Variable, and explain your reasoning. _____

4. Since you will be moving the light probe further away from the light source, what do you predict will occur to the light intensity? What type of correlation do you anticipate?

5. In the space below, sketch what your prediction of the outcome will be and identify your variables in the provided box.
(Do not worry! You will not be penalized for predicting the wrong graph)



6. What is the parent function for this problem? _____

- (a) Linear Function (b) Quadratic Function (c) Square Root Function
(d) Rational (e) Exponential (f) Logarithmic

7. In a few sentences, explain the reasons why you chose that **Parent Function**.
Include notions as the Domain/Range, type of correlation (pattern of increase/decrease), etc. to explain your reasoning.

- Launch Logger Pro
- Double click folder called Light Probe
- Open file called Fade Away

You will now begin to collect data using the Light Probe. Collect data by placing the light probe at different distances.

12. If you choose to use a different parent function, identify the new function and perform an Automatic Curve Fit to find the equation that best describes this situation. ***After you have checked with your teacher, obtain a Manual Curve fit.*** Explain why this is the better parent function. Be as specific as possible.

STOP! DID YOU CHECK WITH YOUR TEACHER? _____

13. ***Use your equation*** to predict the intensity of the light at the given points:
(Show your calculations in the space provided!)

(a) 80 cm. away _____ (b) 5 cm. away _____

(c) 52 cm. Away _____ (d) 200 cm. Away _____

14. How do those values compare with your data collected?

15. Are there any different values from the data you collected? Indicate which values and explain why.

16. What do you consider a **reasonable Domain** for this function?

17. What do you consider a **reasonable Range** for this function?

Now that you have identified a reasonable Domain and Range, think about the next two questions:

18. What do you suppose would be the light intensity directly in front of the light source?

19. How far away do you need to place the light probe for the light fade away completely?

Use the graphs that you printed earlier to demonstrate the following:

20. Assume that the light source is boosted to where the intensity in LUX is increased by 50 units, what would this graph look like compared to the initial graph? Graph this change using one of your original graphs.

21. Assume that your measurements will be collected starting at one meter away, how would your graph change?
