Activity 7: Walk the Line for TI Navigator

Subject Area:
PreAlgebra - Algebra

Topic(s):
When moving at a constant rate either toward or away from the motion detector (CBR) the plot of time versus distance appears linear. The slope of the line is the rate of motion with a negative value indicating a movement toward the CBR, while a positive slope or speed is for motion away from the probe. This slope represents the velocity of the moving object (in meters per second). The starting point appears as the y-intercept of the linear function. The value of the slope can be obtained from guessing and testing, or using the slope formula: $slope = \frac{y_2 - y_1}{x_2 - x_1}$ or from the Linear Regression built into the calculator. This latter process will also yield the y-intercept. The key aspect of this analysis is the constant motion that produces a linear graph, starting at some distance from the CBR.

Prerequisites:
Experience with the CBR, moving in front of the CBR so that they have a since of the plots shown. The students should have some knowledge of the LinReg function and how to use it. Experience with named list, different from L1, L2, etc. The students should be knowledge of ordered pairs. They also should have a familiarity with using the [VARS] – Y-VARS and Functions option with regressions.

NCTM Standards Correlation:

Algebra

Understand patterns, relations, and functions
• generalize patterns using explicitly defined and recursively defined functions;
• understand relations and functions and select, convert flexibly among, and use various representations for them;
• analyze functions of one variable by investigating rates of change, intercepts, zeros, asymptotes, and local and global behavior;

Represent and analyze mathematical situations and structures using algebraic symbols
• understand the meaning of equivalent forms of expressions, equations, inequalities, and relations;

Use mathematical models to represent and understand quantitative relationships
• identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships;
• draw reasonable conclusions about a situation being modeled.

Activity 7: Walk the Line for TI Navigator

Analyze change in various contexts
• approximate and interpret rates of change from graphical and numerical data.

Number and Operations

Understand numbers, ways of representing numbers, relationships among numbers, and number systems
• understand vectors and matrices as systems that have some of the properties of the real-number system;

Compute fluently and make reasonable estimates
• judge the reasonableness of numerical computations and their results.

Measurement

Understand measurable attributes of objects and the units, systems, and processes of measurement
• make decisions about units and scales that are appropriate for problem situations involving measurement.

Apply appropriate techniques, tools, and formulas to determine measurements
• analyze precision, accuracy, and approximate error in measurement situations;
• apply informal concepts of successive approximation, upper and lower bounds, and limit in measurement situations;
• use unit analysis to check measurement computations.

Data Analysis and Probability

Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them
• understand histograms, parallel box plots, and scatterplots and use them to display data;
• compute basic statistics and understand the distinction between a statistic and a parameter.

Select and use appropriate statistical methods to analyze data
• for bivariate measurement data, be able to display a scatterplot, describe its shape, and determine regression coefficients, regression equations, and correlation coefficients using technological tools;
• identify trends in bivariate data and find functions that model the data or transform the data so that they can be modeled.

Activity 7: Walk the Line for TI Navigator

Problem Solving

Instructional programs from prekindergarten through grade 12 should enable all students to—
build new mathematical knowledge through problem solving;
apply and adapt a variety of appropriate strategies to solve problems;
monitor and reflect on the process of mathematical problem solving.

Reasoning and Proof

Instructional programs from prekindergarten through grade 12 should enable all students to—
recognize reasoning and proof as fundamental aspects of mathematics;
make and investigate mathematical conjectures;
develop and evaluate mathematical arguments and proofs;
select and use various types of reasoning and methods of proof.

Geometry

Specify locations and describe spatial relationships using coordinate geometry and other representational systems
• use Cartesian coordinates and other coordinate systems, such as navigational, polar, or spherical systems, to analyze geometric situations;

Communication

Instructional programs from prekindergarten through grade 12 should enable all students to—
organize and consolidate their mathematical thinking through communication;
communicate their mathematical thinking coherently and clearly to peers, teachers, and others;
analyze and evaluate the mathematical thinking and strategies of others;
use the language of mathematics to express mathematical ideas precisely.

Connections

Instructional programs from prekindergarten through grade 12 should enable all students to—
recognize and use connections among mathematical ideas;
understand how mathematical ideas interconnect and build on one another to produce a coherent whole;
recognize and apply mathematics in contexts outside of mathematics.

Representation

Instructional programs from prekindergarten through grade 12 should enable all students to—
create and use representations to organize, record, and communicate mathematical ideas;
select, apply, and translate among mathematical representations to solve problems;
use representations to model and interpret physical, social, and mathematical phenomena.

Activity 7: Walk the Line for TI Navigator

NSES Standards Correlation:

CONTENT STANDARD B:
As a result of their activities in grades 5-12, all students should develop an understanding of

Motions and forces

Unifying Concepts and Processes STANDARD:
As a result of activities in grades K-12, all students should develop understanding and abilities aligned with the following concepts and processes:

Systems, order, and organization
Evidence, models, and explanation
Constancy, change, and measurement

CONTENT STANDARD A:
As a result of activities in grades 5-12, all students should develop

Abilities necessary to do scientific inquiry
Understandings about scientific inquiry

ASSESSMENT STANDARD A:
Assessments must be consistent with the decisions they are designed to inform.

Assessments are deliberately designed.
Assessments have explicitly stated purposes.
The relationship between the decisions and the data is clear.
Assessment procedures are internally consistent.

ASSESSMENT STANDARD B:

Achievement data collected focus on the science content that is most important for students to learn.
Opportunity-to-learn data collected focus on the most powerful indicators.

ASSESSMENT STANDARD C:
The technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation.

The feature that is claimed to be measured is actually measured.
Assessment tasks are authentic.
An individual student's performance is similar on two or more tasks that claim to measure the same aspect of student achievement.
Students have adequate opportunity to demonstrate their achievements.
Assessment tasks and methods of presenting them provide data that are sufficiently stable to lead to the same decisions if used at different times.

ASSESSMENT STANDARD D:

Assessment practices must be fair.

Assessment tasks must be reviewed for the use of stereotypes, for assumptions that reflect the perspectives or experiences of a particular group, for language that

might be offensive to a particular group, and for other features that might distract students from the intended task.
Assessment tasks must be set in a variety of contexts, be engaging to students with different interests and experiences, and must not assume the perspective or experience of a particular gender, racial, or ethnic group.

Time Considerations:

This assessment should take 60 minutes to administer and to discuss results.

Curriculum Objective(s)

The student will demonstrate their understanding of linear functions, including the concept of slope and y-intercept. They will be able to determine the linear function represented by some measured data of time and distance in the form of Y = mX + b by: calculations, guessing and testing, and the use of the Linear Regression function built into the calculator. They also will be able to relate the values of slope and the y-intercept to the motion and position of the object in relationship to the CBR.

Navigator Objectives:

Sending group files of lists to the students, and then collecting the values stored in real variables, strings, and the Y= functions will be a major part of the navigator interactions. Looking at the results from the group with a graph of the distribution of the responses from multiple guess questions will be part of the assessment, while the display of predicted graphs on the teacher's calculator as the students try to fit the data, with discussion on the closeness of fit will be part of other questions.

Abstract:

In this assessment the student will demonstrate their understanding of the linear function y = Mx + B, with emphasis on the values of the slope and the y-intercept as they relate to the speed and direction of the motion with respect to the CBR and the starting position for the moving object, at time zero.

Equipment/Materials:

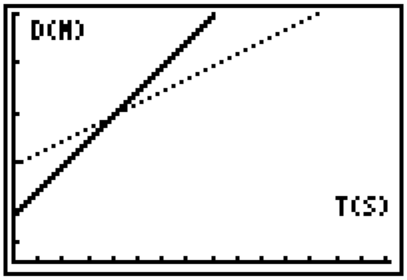
Student Assessment sheet, TI-83 Plus Silver Edition, TI-83 plus PIC8.8XI and ACT07Q2.8XG files, TI Navigator system, and display method for teacher graphs or overheads.

Teacher Notes and Procedures:

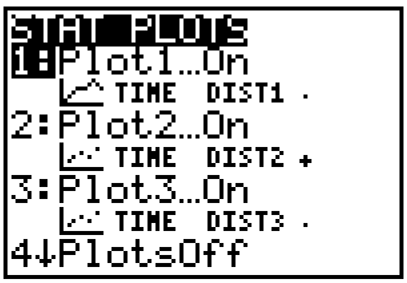
Question 1:

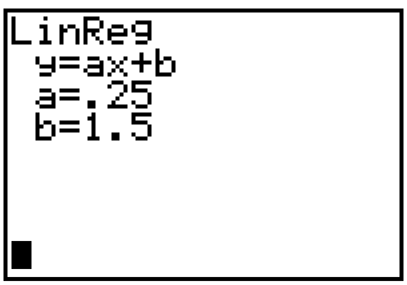
Display the overhead for question 1, or bring up the PIC8.8XI. The solid line equation is y = 1x +1, with a y-intercept of 1, so the dashed line has b>1, leaving only choices B and D. Since the slope is positive, and less than 1, we have the answer of ***D y = 0.5x = 2*** for the dashed line. Have the students store the letter of choice in Str7, and collect them.

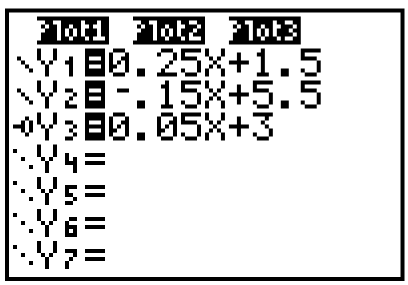
Activity 7: Walk the Line for TI Navigator



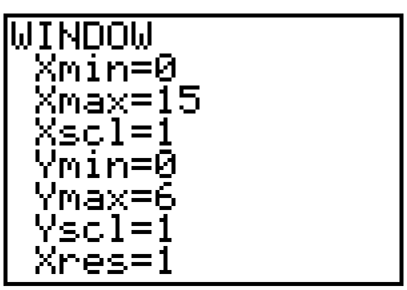
Question 2:
Send the students the group ACT07Q2 that contains the lists for Time and three different Distance sets. All of the data and solutions/set up are in the group ACT072. The students will set up the three plots (one at a time) and get Linear Regression for each. Have them place the solutions in Y1, Y2, and Y3 as the match with the plots TIME vs. DIST1, etc.

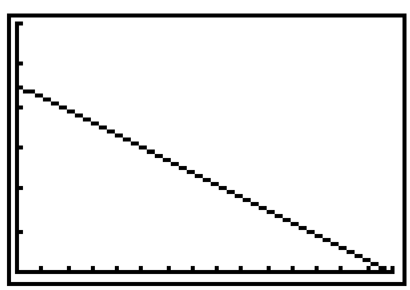






Question 3:
Open the image PIC0, or place the image on the overhead. Have the students “guess” the slope and y-intercept, given the window. Set your window and bring up the image on the overhead calculator. Grab their Y7, one student at a time.. Display their guessed linear using the Bubble Baby with a tail (leaky). Set up the function, turn it off, recall the PIC0 and then after it displays, turn on the graph in Y7. You may place a series of equations on the Y7 line using the Nixons, as shown below.





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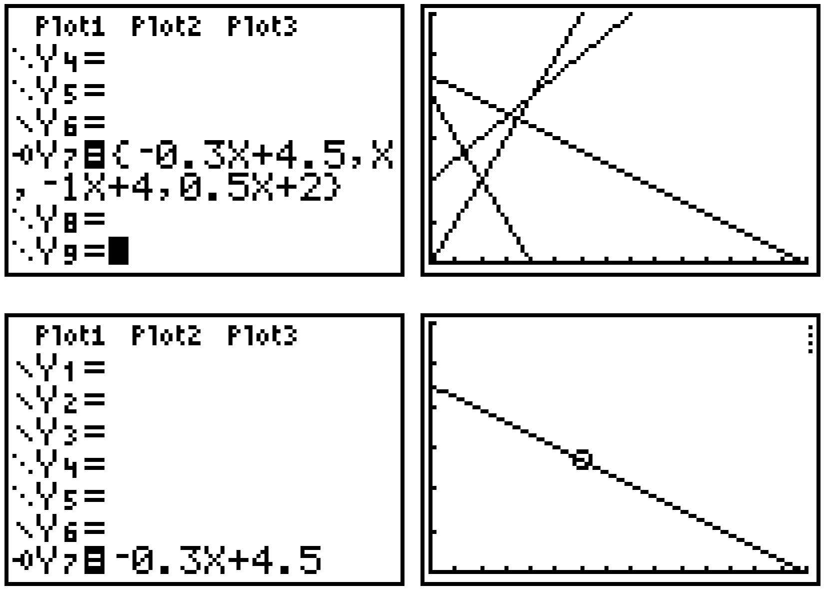

Y7 = -0.3X + 4.5 is the correct answer.

For questions 4-5-6 collect the values of the variables S, T, and U, and look at the results as a whole class.

Question 4:
Which of the above has the largest y-Intercept?
The students should store ***2 in S***. ***Y2 = 2X + 3***

Question 5:
Which of the above has the smallest y-Intercept?
The students should store ***1 in T***. ***Y1 = X***

Question 6:
Which of the above looks the steepest?
The students should store ***3 in U***. ***Y3 = -4X+1***

Background Information:

Students should have developed a connection between the direction of the motion and the slope of the line produced, with a motion away being of positive slope, a motion toward the CBR being of negative slope, and standing still related to a zero slope. A slight awareness of speed is implied in the assessment, but the connection to the magnitude of the slope is not essential.

Student Handouts:

See attached in Word and PDF.

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Miscellaneous Documents:

Overheads of graphs used in the assessment in Word and PDF form are included.

Additional Software or APPS:

PIC8.8XI and ACT07Q2.8XG files.