Mathematical Models with Applications Clarifying Lessons: What's Your Rate of Change?

OLD Resources. These resources have NOT yet been updated to align with the revised secondary mathematics TEKS. These revised TEKS were adopted by the Texas State Board of Education in 2005, with full implementation scheduled for 2006–07. These resources align with the original TEKS that were adopted in 1998 and should be used as a starting point only.

What is a Clarifying Lesson?

A model lesson teachers can implement in their classroom. Clarifying Lessons combine multiple TEKS statements and may use several Clarifying Activities in one lesson. Clarifying Lessons help to answer the question "What does a complete lesson look like that addresses a set of related TEKS statements, and how can these TEKS statements be connected to other parts of the TEKS?"

TEKS Addressed in This Lesson

1.B, C (use a variety of strategies and approaches to solve both routine and non-routine problems)

2.A, D (use graphical and numerical techniques to study patterns and analyze data)

3.C (develop and implement a plan for collecting and analyzing data in order to make decisions)

Materials

- an electronic data-collection device, such as a CBR™, connected to a viewscreen graphing calculator
- overhead projector and screen
- graphing calculators
- Activity sheet and Assessment sheet

Related Resources

Experience with a motion detector, specifically with a distance/motion program.

Lesson Overview

Students use numeric techniques to write the equation of a line that represents motion data.

Mathematics Overview

Students use regression methods available through technology to select the most appropriate model to describe collected data and use the model to interpret information.

Set-up (to set the stage and motivate the students to participate)

1. The classroom should be set up with an aisle down the middle. Set up an electronic data-collection device, such as a CBR, pointing down the aisle, hooked to a viewscreen calculator so the class can see both the students walking down the aisle and the data projected from the calculator on a screen in front of the room.

2. Relate the following situation to your class: Suppose you start 2 feet away from a chair and walk away at 1.5 feet per second. Complete Table 1 on the activity sheet to show where you are at each second. (1.B)

Time in seconds	Distance in feet
0	2
1	3.5
2	5
3	7.5
10	?
t	?

Guiding Questions (to engage students in mathematical thinking during the lesson)

How can you find your distance from the chair at 10 seconds? (Multiply 10 by 1.5 and add 2.) (1.B, C)

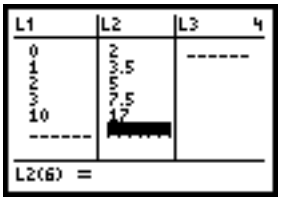
Write a sentence to describe how you can find the distance if you know the time. (Distance is 2 plus 1.5 times the time.) (1.B; 2.A, D)

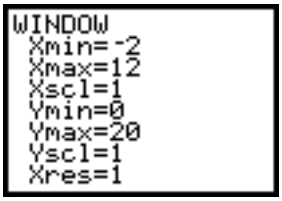
Translate the sentence to an equation. (Distance is 2 + 1.5 * time or d = 2 + 1.5t) (1.B, 2.D)

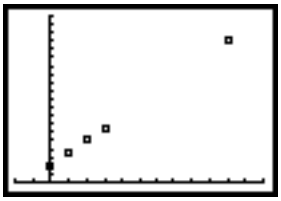
How can you represent this in your table? (1.B)

Time in seconds	Distance in feet
0	2
1	3.5
2	5
3	7.5
10	17
t	$2+1.5t$

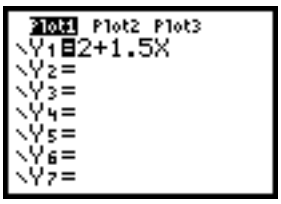
What would a scatter plot of your data look like? (1.B, 2.A)

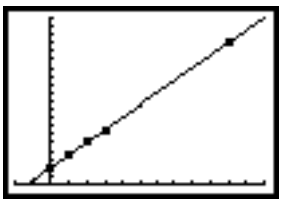






Show that your equation contains the points by graphing it. (1.C, 2.D)



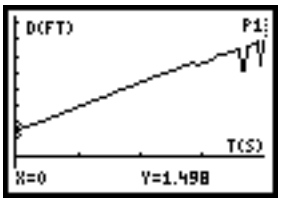


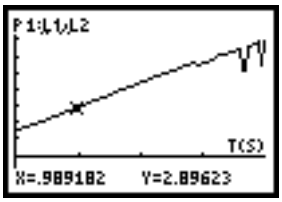
3. Run a time vs. distance program. For example, use the following screens from the CBR Ranger program to set up the experiment and then follow the instructions on the screen.

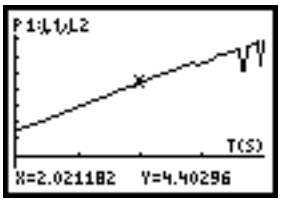
4. Ask a student to walk in front of the electronic data-collection device as follows: Start about 2 feet from the electronic data-collection device and then walk away from the electronic data-collection device.

5. When the student has produced a satisfactory graph, press ON, quit, graph. You should see the graph again.

6. Trace to the two points where time = 0 seconds, time = 1 second, and time = 2 seconds. (1.B, C; 2.A, D)







7. Have students use the information from the traces to fill in the table. (1.B, C; 2.A, D)

x	y
0	1.5
1	2.9
2	4.4
10	?
t	?

Guiding Questions (to engage students in mathematical thinking during the lesson)

How can you use the points to find how fast you were going? (Take the difference over 1 second, about 1.4 feet per second.) (1.C; 2.A, D; 3.C)

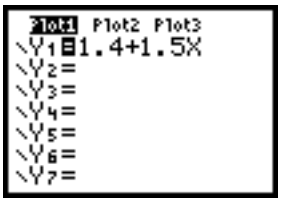
Where did you start? (1.5 feet away from the electronic data-collection device) (3.C)

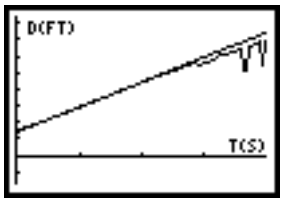
How can you use your rate and where you started to figure out where you will be in 10 seconds? (1.4 plus 10 times 1.5) (1.C, D; 3.C)

Write a sentence to describe how you can find the distance if you know the time. (Distance is 1.4 plus 1.5 times the time.) (1.B; 2.A, D)

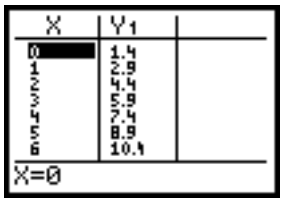
Translate the sentence in words to a sentence in symbols. (distance = 1.4+ 1.5 * time or d = 1.4 + 1.5t) (1.B, 2.D)

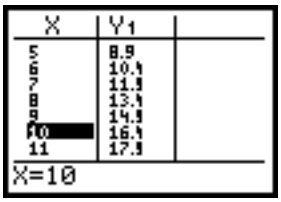
Type the equation into the "y =" menu and graph it. (2.A, D)





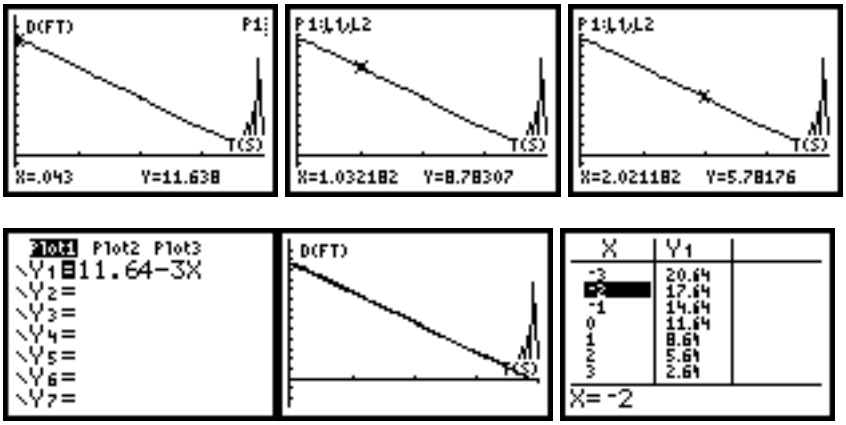
Use the table to check your prediction for where you will be in 10 seconds. (3.C)





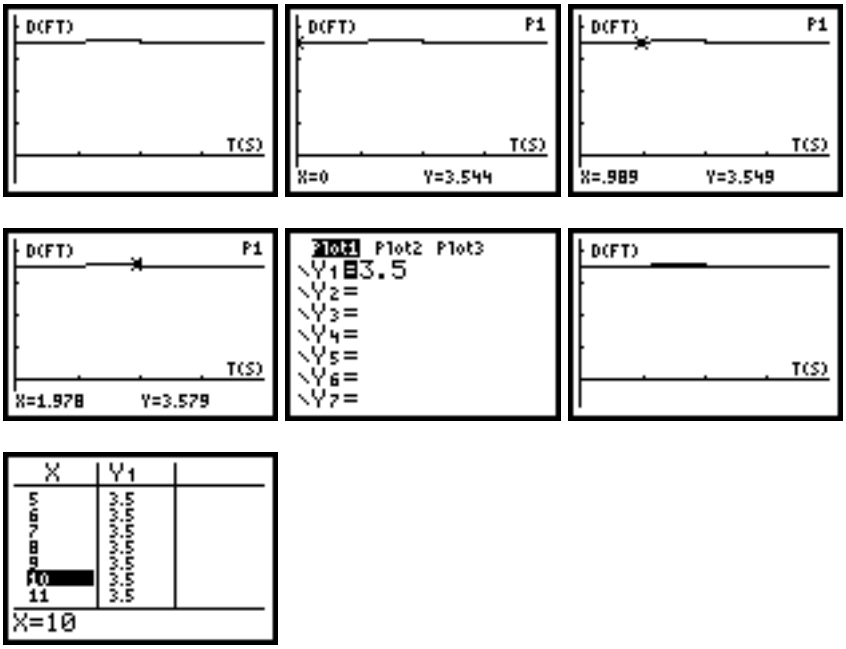
8. Have students repeat a similar procedure for the rest of the walks on the Activity Sheet: find an equation to fit the data and check their prediction with a table. Examples of different walks:

Ask a student to start 11 feet away and walk toward the electronic data-collection device.



(Where were you 2 seconds before?)

Ask a student to stand approximately 4 feet from the electronic data-collection device and stand still for the whole 4 seconds.



Teacher Notes (to personalize the lesson for your classroom)

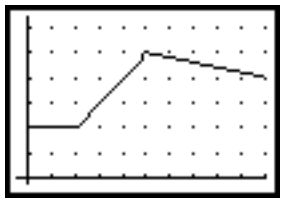
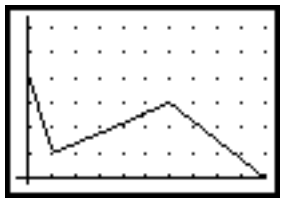
Summary Questions (to direct students' attention to the key mathematics in the lesson)

- What patterns do you see in the linear models for each walk? (2.A, D)

- What part of each linear model represents the distance you started from the electronic data-collection device? (2.A, D; 3.C)
- What does the coefficient of *t* in each linear model represent? (2.A, D; 3.C)
- What does it mean when the coefficient of *t* is negative? Positive? (2.A, D; 3.C)
- How did you use the graphs and the data tables to determine your rate of walking? (1.C, D; 2.A, D)
- What linear model could be used to represent distance from the electronic data-collection device of someone who starts *f* feet away and walks at a rate of *w* feet per second away from the electronic data-collection device? Toward the electronic data-collection device? (2.A, D)

Teacher Notes (to personalize the lesson for your classroom)

Assessment Task(s) (to identify the mathematics students have learned in the lesson)

1. C
2. B
3. A
4. 
5. 
6. y = 3 + 0.5x
7. y = 4.5 + 2.5x
8. y = 2 + x
9. y = 0 + (2/5)x

10. $y = 5 - 2x$

11. $y = 4 + (1/5)x$

12. You rode your bike to the park at a rate of one block per minute for 3 minutes. Then you talked to your friend at the park for 2 minutes. Then you both walked back to your house at a rate of 0.6 blocks per minute for 5 minutes.

Teacher Notes (to personalize the lesson for your classroom)