Lesson Plans
Session 3

Ellen Muse

Name of Lesson: Tossing a Ball

Mathematical Topic: Algebra: Modeling Quadratic Functions

Course: Algebra 2

Time Allocation: 85 minute block (will take less if more than 1 CBL unit is available

Pre-requisite Knowledge: Students must be familiar with the following topics:

- Standard form of a quadratic function
- Identifying the vertex, equation of axis of symmetry, and direction of opening when given an equation in the form $y = a(x-h)^2 + k$
- Analyzing the value of "a" (ie. Direction of opening, comparison of width with the parent function)
- Writing an equation for the function when given the following information:
  - Three points
  - Vertex and another point

Objectives: This activity uses the CBL and a motion detector to gather data while tossing a ball. Students will see the relationship between height of the ball and time. Students will use the TI-83 Plus to do a quadratic regression analysis as well as determine their own equation using the data, and compare these to the position function that determines the position of an object as a function of time.

Needed Materials & Equipment: TI-83 Plus calculators for each student and a TI-83 Plus overhead viewscreen, CBL unit, Program "FALLOBJ", link cables for students to share the data, graph paper, rulers, and a large piece of paper (flip chart paper works well) for each group to use for presentation of findings. Group sizes (no larger than 4) should be pre-determined based on the availability of CBL units.

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Procedure:

Using the directions for the collection of data, the teacher should demonstrate the use of the CBL using the TI-83 Plus Viewscreen. After a short demonstration, have each group gather the data using the CBL unit as described in the Student Activity Sheet labeled "Lab: Modeling Quadratic Functions/Tossing a Ball"

Students may then work with their group completing the "CBL Lab (Quadratics)" Activity Sheet. They will be given a large piece of paper for the group to summarize their findings for a class presentation.

Each group will present their findings to the class. Leave each presentation sheet posted in the front of the class. When all groups have finished presenting, ask students to make note of the similarities and differences between each groups' findings. They will need these notes for their follow-up assignment.

Assessment:

A classwork grade will be assigned for the class presentation.

Attachments:

Lab: Modeling Quadratic Functions/Tossing a Ball
CBL Lab (Quadratics)

Follow-up Assignment:

Journal Assignment: Write a journal entry discussing the similarities and differences between your group's findings and the other groups in class. Discuss why your graphs were different from other groups. Were there any common factors?

Sources:

I put this activity together several years ago, and to be honest, have no recollection where I found it. I have tried searching the TI website for the "FALLOBJ" program and could not find it. I have since adapted the activity for my class.

Algebra 2
CBL Lab (Quadratics)

Name_____
Date_____

A function that gives the position of an object as a function of the time, t, is a ***position function***. The position of a free falling object can be modeled by the quadratic equation, $s(t) = \frac{1}{2}gt^2 + v_i t + s_i$ where g is the acceleration due to gravity (On Earth, the value of g is $-32 ft/\sec^2$.), v_i is the initial velocity and s_i is the initial height.

Analyzing Our Data:
The data that you collected is stored in L3 (time) and L4 (height). You can find them by pressing **STAT** and moving the cursor right to L3 and L4.

1. Using the data in the lists and/or the trace function on your calculator, write an equation for your graph. Show all calculations in the space provided or on a separate sheet of paper and put your final equation in standard quadratic form. Enter the equation in "$Y_1 =$". Pressing **GRAPH** will now graph this curve on your plot.

2. How does it compare to the position function $s(t) = \frac{1}{2}gt^2 + v_i t + s_i$?

3. When does the falling object's acceleration due to gravity completely overcome the initial velocity? Explain.

4. Now perform a quadratic regression analysis of your data in L3 and L4 using your calculator. Press **STAT**, move the cursor to **CALC**, press **5** **L3** (press **2nd** **3**) **,** **L4** (press **2nd** **4**) **ENTER**. The values for a, b, and c will appear on your screen. What is the resulting position function of the object? Press **Y=** and move the cursor down to "$Y_2 =$". Now press **VARS**, press **5** (Statistics) and move the cursor to **EQ**. Now press **1** and the regression equation should appear in "$Y_2 =$". Pressing **GRAPH** will now graph this curve on your plot.

5. How does this equation differ from the one you derived in #1 above? Explain why they may be different.

6. Your group must be prepared to present the findings to the class. Prepare your presentation on the paper that will be provided to you. Be sure to include the plot and two graphs (done on graph paper) as part of your presentation.

Algebra 2 **Name**_____

Lab: Modeling Quadratic Functions **Date**_____

Tossing a Ball

Directions for the collection of data:

- Be sure that your calculator contains the program, "FALLOBJ", before starting.
- Clear the lists stored in your calculator (2^{nd}>Mem>4{ClrAllLists}>Enter). Your calculator should read "done" when the function is complete.
- Make sure the CBL unit and the graphing calculator are turned on.
- Start the FALLOBJ program on the calculator
  (Prgm>bring the cursor down to fallobj>enter)
- The motion detector will start ticking.
- Have someone hold the ball about 1.5 feet above the motion detector.
- As soon as someone presses "trigger" toss the ball straight over the motion detector and catch it about 1.5 feet above the motion detector.
- After the object is caught, the motion detector will stop ticking, and a graph will be displayed on the calculator.
- Press "enter". If you are happy with the graph, press "1". If you are not happy with the graph and want to repeat the experiment, press "2".
- If you press "2" the motion detector will start ticking again. Press "trigger" and toss the ball and repeat the steps above until you get a satisfactory graph.
- Once you are pleased with your graph, DO NOT TURN OFF YOUR CALCULATOR! Let the next group know that they may use the motion detector.
- You will now need to remove the extraneous data from your graph:
  Move the cursor to the left side of the graph and place it where the valid points start. Press "enter". A vertical line will appear that will eliminate all the extraneous data from the left side of the graph. Now move the cursor to the right side of the graph to eliminate the extraneous data to the right. Press "enter" and another vertical line will appear. The graph will now be regenerated to only include the portion of the graph that you have selected.
- You should now have a graph of a parabola on the calculator screen.
- It is now safe to turn off your calculator.
- Return to your seats and, using the link cable, transfer Lists L_3 *and* L_4 to the calculators of the other group members. Each group member must then create a scatter plot on their calculator.
- Your group may now start working on the activity sheet titled, "CBL Lab (Quadratics)".