Lesson Title: *Exponential Functions and Sequences 3.1.4: What if it does not grow? Exponential Decay*

Note: This is a lesson that I already use in class. I have adapted it to reflect the strategies learned in ED530K from reading Eric Jensen's *Teaching with the Brain in Mind*

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Materials:

- 100 pennies per team
- One paper cup per team
- 3.1.4 resource page (graph template)
- One large piece of butcher paper per team
- $y = ab^x$ frame with meanings of a and b labeled

Arrangement:

- Individual desks need to be in groups of 3-4 before class begins
- Materials need to be located in different spots to allow groups to send different delegates to get each item.

Lesson Activities:

1. As students enter, greet them at the door with a hug, handshake, or high-five (their choice).
2. Once they are in the room, ensure that they are getting out their materials and working on their warm up, which is to answer the question displayed…
    a. We have been working with rules in the form ab^x Where a is the amount of the initial term and b is the rate of growth. When the _____ is more than 1, the situation involves growth.
    b. What do you predict will happen if the rate of growth is less than 1?
    c. Compare and contrast exponential growth and exponential decay.
3. During the warm up, check in with students who seem distracted or who are having a difficult time. Ask them what they need from you in order to be successful during class. Do they need to take a lap outside to get themselves composed? Do they need to spend five minutes journaling about their situation? etc.
4. After 5 minutes, when the timer rings, have students stand up. Instruct them to take their journal and walk five steps in any direction and then freeze. Then, ask them to find a partner near them with whom they will review the warm up.
    a. As students discuss, circulate to monitor their understanding.
        i. Help to correct any errors in thinking as necessary.
        ii. Pre-select a student to share their response to b and c.
5. After 2 minutes or when students seem ready, get their attention by ringing a bell.
    a. Ask them to remain standing.
    b. Tell them to say the answer to the fill in the blank as a group when you put your hand up and say, "We have been working with rules in the form ab^x

Where a is the amount of the initial term and b is the rate of growth. When the (raise hand) GROWTH RATE is more than 1, the situation involves growth."

c. Ask pre-selected students to share their responses:
    i. What do you predict will happen if the rate of growth is less than 1?
    ii. Compare and contrast exponential growth and exponential decay.
d. Ask for a volunteer to agree or disagree with the prediction about the rate of growth and explain their thinking.
e. Explain that today, students will be looking at a few situations involving exponential decay to learn more about exponents.
f. Ask students to return to their seats.

6. Ask students to go to page 76 and read over the directions for the "Penny Lab" independently.
    a. Have a volunteer summarize the first step of the lab, which is to put 100 pennies in a cup and dump them out. Demonstrate this for students.
7. Have each table send one representative to get the butcher paper to cover their desks.
8. Have each table send a different representative to get the pennies/cup.
9. Have each table send a different representative to get the resource pages.
10. Have each group dump their 100 pennies onto the butcher paper and then freeze.
11. Get students' attention and model the second step, which is to remove all pennies showing tails and record the number of pennies left in a table as shown in their book.
    a. Explain that each student should make his or her own table in the journal.
    b. Explain that they will repeat the process just modeled until there are 0 heads-up pennies left.
12. Post the directions for the rest of class on the board and explain that students should first complete the penny lab while working cooperatively with their group as described on page 76. Then, they should read the board for further instructions.
    a. Complete the Penny Lab on page 76 with your group.
    b. As a group, answer the questions from problem 3-49.
    c. Independently work on problem 3-50.
13. Allow teams to work on the Penny Lab. As they work, go around to monitor understanding and assist as necessary.
14. 15 minutes before the end of class, if teams have finished problem 3-50, bring the class together and put the Lesson 3.1.4 Resource Page on the document camera. If there is no time for this today, make time at the beginning of class the next day. It is important that students are allowed to finish the experiment and to reflect on the questions presented.
    a. Have one representative from each team bring up his or her graph and post it on the board.
        i. Give students 30 seconds to talk to their groups about how the graphs compare to each other and the graphs we have been studying with exponential growth equations this unit.

    ii. After 30 seconds, select students to share their thoughts.
b. Have a volunteer share his or her equation for the penny lab by filling in the $y = ab^x$ frame. Have him or her explain why he or she chose each value.
    i. It should be $y = 100(½)^x$ part.
c. Ask students What is the y-value for the point on the graph when x = 0 ?
    i. They should notice that the initial value, or y-intercept, corresponds to $y = 100(½)^0$.
    ii. Plot this point.
d. Add points for positive values of x based on students' findings.
e. Ask students to look at 3-50 and ask what f (-1) might represent.
    i. If students interpret f (-1) to mean one half-life before the 100 grams were measured, then they should see that if the curve continued into negative half-lives, its output value at -1 would be 200, so f (-1) = $y = 100(½)^{-1} = 200$.
f. Next ask the class to figure out the value of the function when x = -2 using their graphing calculators.
    i. Ask what this means in context.

15. 5 minutes before the end of class, explain that tomorrow students will learn about different contexts in which exponential decay happens.
16. Have students clean up all of their materials.
17. Tell students that on the way out, you will ask each of them what happens to the function if the rate of growth is less than 1, and they should be able to tell you.
18. When it is time for class to end, dismiss students and give them a hug, handshake, or high five (their choice)