Mass of an Object – Candy

How much does one piece of candy weigh? It seems like a simple question, and in many ways it *is* a simple question, but the procedure we use to answer that question will dramatically influence our ability to predict the mass of the next piece of candy we take from the bag and the confidence with which we make that prediction. Measuring a physical quantity involves not just getting "the" answer, but also including some indication of how much that answer can be trusted or repeated.

Goals of the Experiment:

1. Gain experience with preparation and analysis of graphical data
2. Use trends to predict future measured values from existing data
3. Analyze and appreciate uncertainty ("error") in experimental measurements

Procedure: {Work in pairs.}

1. Get a cup of candy. You will be weighing varying numbers of candies to determine the mass of a single candy. Be sure to note the candy type.
2. When it is your turn at the scale, weigh some number of candy pieces. {See "Using the Scales" below.} Then weigh a different number of candies. Repeat until you have measured the mass of at least 9 different numbers of candies.
   A few guidelines:
   a. Weight at least 10 candies each time.
   b. Don't just keep adding pieces. After each weighing, dump out the candies that were just weighed and re-count a new number of candies.
   c. Weigh a broad range of numbers of candy pieces. For example, DO NOT weigh 10/11/12/13/14/15/16/17/18 candies as your 9 weights; spread the numbers out more.
   d. Don't worry about "even" numbers of candies. Your candy counts don't have to be evenly spaced. They *can* be evenly spaced, but there is no advantage or disadvantage to using exactly equal spacing.
3. Enter your data in the correct area of the class spreadsheet.
4. "Dispose" of your candy in the manner you feel is most appropriate.

Using the Scales:

1. Make sure the scale is sitting flat on the table.
2. Place an empty cup on the scale and tap the "tare" button. This will set the scale at zero.
3. Count candy pieces into the empty cup, but try not to look at the weight display while you are counting. Why not? You might introduce "observer error" or "observer bias" into your data.

Data Analysis:

Mathematical Analysis #1:
For each of your nine masses, calculate "grams per candy". List these from largest to smallest and take the average of these 9 values of candies. How close to the average is the middle value in your list?

Determine the "range" of your data by subtracting the smallest of your values from the largest of your values. For ideally distributed data, half of the range should be above the average and half should be below the average. Divide your range by 2. This is one way to estimate the uncertainty or "error" in your data. For relatively small data sets, using "range over 2" for error is usually reasonable. Report your average and error:

Mathematical Analysis #2:

Using the raw data you collected, calculate the average mass of a candy piece by dividing the *total* mass of the candy for all nine samples by the *total* number of candy pieces used in all 9 samples. How does this number compare to the average you calculated in the previous section? Is this value within the error you reported in the previous section?

Graphical Analysis:

Prepare a graph of mass of candy pieces vs. number of candy pieces for the nine samples you measured. Your nine points should be approximately linear; use a straightedge to draw a line that fits your nine points. The slope of a line is equal to the change in the "y" variable divided by the change in the "x" variable. In this case, "y" is grams of candy pieces and "x" is number of candy pieces, so the slope of the line defined by your nine points should be "grams per candy". This means that the slope of the line should be the average mass of a piece of candy. Determine the slope of your fit line. How does the slope of your fit line compare to the average mass of a piece of candy you determined in the previous sections? Is the average mass {determined using the slope of the fit line} within the error you reported in the previous section?