**LESSON PLAN OUTLINE- Secondary Mathematics Version**

1. TITLE OF LESSON: *Discovering the Deviations*
2. CONTEXT OF LESSON: Students already understand the components that make up box whisker plots. They can make and compare box and whisker plots. Computing mean absolute and standard deviation can be tedious, so I could expect some resistance in the amount of number crunching and possibly some difficulty remembering how to use the calculator. Statistics relates to real life so some students will find it interesting. I am also incorporating food, which may help peak their interest. This lesson will follow a review day of statistics and box and whisker plots and will lead into the discovery of z-score which will be in the following lesson.

LEARNING OBJECTIVES and ASSESSMENT:

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| Learning Objective | Bloom | Assessment (Formative/Summative) |
| Students will calculate the mean absolute and standard deviation without use of formal formula | Apply | Formative: Correct completion of lab sheet  |
| Students will show how the data is dispersed using both mean absolute deviation and standard deviation | Understand | Formative: * Completion of lab sheet
* Exit slip: 1) one thing they learned 2) one thing they don’t understand
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1. RELATED 2009 VIRGINIA STANDARDS OF LEARNING: A.9 The student, given a set of data, will interpret variation in real-world contexts and calculate and interpret mean absolute deviation, standard deviation, and z-score.
2. MATERIALS NEEDED: Box of raisins for each student, napkin for each student, Raisins Lab Sheet, overhead projector or Smart Board, graphing calculator
3. PROCEDURE:

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| Time | Mathematical Tasks to be Used,Teacher Thoughts/Actions/Questions | Anticipated Student Comments, Questions, Actions, and Strategies |
| 10 min | BEFORE: Warm up: Sigma/Summation notation and examples. (This will familiarize them with the notation of sigma and what it means in a basic way in preparation for the calculation of the deviations.)  This notation tells us to add all of the *ai* for all integers starting at 1 and ending at *n*. Ex. Ex. x + 5 from x =1 to x = 6.Ex. -3x^2 from x = 1 to x = 5. Ex. 4x - 3 from x = 1 to x = 3.We will be using summation today in the statistical calculations we will do. To begin, we will do an experiment as a class to collect some data. Teacher will solicit help of a few students to hand out raisins, napkins and lab sheets.  | Students may be uncomfortable with the notation, but encourage them that they have been adding for years, it’s just one big addition problem. |
| 50-60 min | DURING: * Page 1 completed together as a class.

Teacher will collect students estimates of how many raisins are in the box. Then students will count how many they actually had and report that data to the class. With that information students will create individually stem-n-leaf plots and dotplots. This part should be review and go rather fast. Teacher will also create the plots on overhead or Smart Board so the students may compare their answers. (At this time students may eat or throw away their raisins.)“Who can remind us how we create a stem-n-leaf plot?”“Is there a volunteer?”#4-the spread of the data should be more spread out with the estimated data. When making comparative dot plots, the increments must be same on the two lines and they must start and end with the same number.* Page 2 should also be done together as a class.

Mean Absolute Deviation measures *deviation* and is most useful with data sets involving *outliers*.Input data points in L1 in calculator. They can compute the difference for column two by hand for a few data points, but then show them how to input a formula in L2, which will calculate differences simultaneously. We want the sum of the entire column. Show that it is 0.The third column must be positive. They can also input a formula in L3. Sum of the third row divided by the number of data points is the MAD. MAD shows how data is dispersed. Taking the absolute value is necessary because if we didn’t, the sum of the difference would always add to 0 and that doesn’t give us very much information on how the data is dispersed. * Page 3. Students may now choose to work alone or in pairs. Teacher circulates classroom to answer questions.

Teacher quickly gives correct MAD for the actual data and answers questions. *Assessment*: Based on how many students found the MAD correctly, teacher will know how much to assist, whether they can be left alone or whether they need to do the next one together as a class.Summary statement about MAD and discuss how it represents a dispersion. Teacher will draw the dotplot across a chalk board and will invite one student to come up to be the leap frog. The leap frog IS the mean absolute deviation. The frog will start at the mean and jump one MAD above the mean. (+1 MAD because we jumped to the right of the mean.) Teacher will show the calculation and draw a vertical line at that number. The frog will return to the mean and jump one MAD below the mean. (-1 MAD because we jumped to the left of the mean.) We can continue “jumping” by MAD, or counting by MAD’s, until all the data points have been accounted for. “How many MAD’s did it take to include all data points?”“What does that say about our spread?”“Do you suspect that it will take more or less MAD’s with the estimated data?”* Begin page 4 with brief discussion about stdv. It is also a “leap frog” that shows us how spread out the data is.

Standard Deviation is another way to measure *deviation* and is used most regularly in statistics. However, instead of taking the absolute value of the difference, it is *squared.*In pairs, students will then be given time to complete page 4. As they finish, they should compare answers with another group/individual. As a class, count by standard deviations to show the dispersion to solidify understanding and process.* Student will then complete page 5

independently or in pairs and turn in to teacher as they complete the lab sheet. Teacher will circulate classroom as needed. Page 5 will be the best indicator for the teacher as to how well the students met the objective. | Those who finish early should be encouraged to compare answers with each other or help a neighbor who may need assistance.Students are working individually following teacher direction.Students may struggle with the key strokes on the calculator. If there is more than one at a time, teacher may assign a capable student with someone who is struggling to help with calculator use.I suspect this visual will be fun and interesting for the students. Great for kinetic learners. Students do not need to write this down, but just participate.Answers will vary.“The more jumps, the more spread out the data.”“The estimated data is more spread out, so we will need to jump more times.”Students should be feeling more confident, but some may feel burnt out. It can be a bit tedious. Encourage mastery of calculator to assist with calculations. |
| 10 min | AFTER: Highlight any group/individual’s effort or discovery. Once all papers have been collected, lead discussion.“Why do we care about these two ways to calculate dispersions?”“What do they tell us?”“What things in real life would we rather have a small/large deviation from the mean?”Ask students to complete exit slip. 1) What is one thing they learned or found interesting? 2) What is something they don’t understand?This will be useful in deciding how much assistance they will need the following day. | If mean is “the normal” it tells us how normal/abnormal something is.Product ratings, high school’s standardized tests scores,  |

1. MEETING THE NEEDS OF ALL STUDENTS: There may be students that need to write keystrokes down to help with all the steps on the calculator. Special pairings may be necessary to help struggling or unmotivated students. Advanced students or ones that finish early could put more thought into real life situations that deal with how far something is from the mean. They could present their ideas/findings to the class the next day.
2. WHAT COULD GO WRONG WITH THIS LESSON AND WHAT WILL YOU DO ABOUT IT? Students could get frustrated with the amount of number crunching, or overwhelmed by the big empty tables. Perhaps circling the “must have” boxes might be helpful for them to see that they don’t HAVE to write everything down.
3. CONNECTION TO CTA: Colleen Watson’s raisin lab and leap frog idea is obviously what I used as the basis for this lesson and it guided me in making a lab sheet. I thought this lab would be a more simple, yet effective to introduce MAD and stdv, more so than other things I have seen. I thought it would go perfectly before a lab I have done before on z-score. I tried thinking about TAPS, that Dan Mulligan taught about. This is a meaty topic but breaking the time up between whole class discussion, alone and in pairs or small groups, I thought would help keep them going.

