

Teacher Observations
of
Students Studying
Box and Whiskers Plots
from *Dealing with Data*

By: James Eiser
Bristol Township School District
Attn: Joe Merlino
LaSalle University
Greater Philadelphia Secondary
Mathematics Project

1. **Purpose and Category Selection**

This paper is for the Graduate Mathematics Education Course sponsored by the Greater Philadelphia Secondary Mathematics Project. I have completed the course requirements 1, 2, and 3 and this work falls under final course requirement 4, category b., A Portfolio or Journal. The intention of this paper is to discuss and compare two pedagogical techniques I employed in the teaching of the box and whiskers plot to the students in my eighth grade classes. In addition, my observations and reflections are included.

2. **Background and Setting**

Having started my teaching career on January 3, 2000, I am relatively new to the teaching profession. At that time I was hired by a Bristol Township School District to teach at Neil A. Armstrong Middle School (N.A.A.). I am one of two eighth grade Algebra I teachers and my students number slightly more than one-half of the eighth grade class, known as the B-Team. All grade levels at N.A.A. are split into two teams, A or B, including both the teachers and students. The team grouping designations have no academic, social or other quantitative or qualitative meaning.

The five periods I teach throughout the day are non-tracked heterogeneous environments. The students in these classes include 58 females and 63 males, 48% and 52% respectively. The total number of students is 121, of which 15 are African Americans and 106 are Caucasian, 12% and 88%, respectively. These numbers are consistent with the previous year's students in the five classes I taught from January 2000 to June 2000.

My work and observations will involve all five of my own classes' students. I will not be differentiating between the five periods, but rather will be making commentary on the group as a whole. Given the nature and make up of the student population as just stated, I believe this to be a reasonable approach.

In terms of the rollout and implementation of the Mathematics in Context (MiC) series at N.A.A., currently the two lower grade levels, sixth and seventh grades, are fully utilizing the series. However, the eighth grade is not scheduled to utilize the MiC series until the start of the 2001-2002 school year in September 2001. Therefore, I am currently teaching an Algebra I course curriculum supported by the *Holt Algebra I* textbook copyright 1992, 1986.

3. Mathematical Content and Pedagogical Techniques Implemented

The unit I decided to utilize to supplement the *Holt Algebra I* textbook was *Dealing with Data*. I have been attending regularly the scheduled workshops for both the sixth grade and seventh grade units selected to be taught in Bristol

Township School District. This particular unit, *Dealing with Data*, was presented to my district's math teachers just this past autumn in 2000. Although this unit is listed as a sixth grade unit on the MiC on-line order form as well as the Bristol Township School District Sequencing suggestions, I believed it would be an ideal fit into my current curriculum. The presenter was Mr. Paul Ridgeway. His presentation of the material as well as the classroom materials he supplied to us are what convinced me of unit's appropriateness to my own eighth grade classes.

I was aware of the importance and need for my students to learn and understand the material covered in the *Dealing with Data* unit. The foremost reason was that nearly all eighth grade students in the State of Pennsylvania are required to take the Pennsylvania System of School Assessment (PSSA) test. Included on this assessment was to be a projected set of ten questions out of the eighty-five total multiple choice questions, or 12%, relating to Pennsylvania Mathematical Academic Standard 2.6, Statistics and Data Analysis. Experience with my students had already shown me the lack of comprehension of the math concepts in this strand of mathematics.

Unfortunately, I was unable to simply utilize the *Dealing with Data* unit materials as they were presented during the workshop. This was due to the fact that I did not have access to a class set of books for my students to use. Therefore, I selected specific concepts and pedagogical techniques from the *Dealing with Data* unit to utilize with my five eighth grade classes. The concepts were the ones I deemed to be the most fundamental and useful and consequently to have the highest probability of being asked on the PSSA test. The Conceptual

and Procedural Knowledge Goals I selected were both computational and graphical. The computational concepts selected and their related unit section references were mean (Section D), median (Section E), mode (Section C) and range (Section D). The graphical concepts selected and their related unit section references were the stem and leaf plot (Section C) and the box and whiskers plot (Section E).

Once the computational and graphical concepts were identified, a data set with which to work from was needed. The data set I utilized revolved around tornadoes in the United States. Specifically, the data included tornado occurrences, tornado inflicted fatalities and tornado inflicted injuries all compiled by state between the years of 1950 and 1994. The data source which was a student handout, is attached as Exhibit I (two pages). There were two reasons that particular data set was chosen. The first was that, as stated previously, I did not have a class set of MiC *Dealing with Data* unit books to use. Therefore, the numerous data sets contained in the unit books were unavailable. The second reason was to facilitate a team teaching unit that crossed both the math and science curricula. Thus in conjunction with my unit on these statistical concepts, the same students were learning the scientific concepts of tornadoes in their science classes. So as students used the handout noting which states had the highest frequency of tornado occurrences and their locations on the accompanying map, they could answer my questions pertaining to why “tornado alley” was located in the southern mid-west. Their responses included flatness of the land and cold Canadian fronts meeting warm and wet fronts from the Gulf of Mexico.

The pedagogical techniques and teacher led discussions I used to teach these statistical concepts followed directly from the *Dealing with Data* unit book and the supplemental materials I received during the workshop for this unit. As part of this paper I have not gone into great detail with all of the computational and graphical concepts I covered in class. Rather, I focused on the box and whiskers plot and what I observed.

The unit I presented followed a very similar progression of ideas to the layout in the *Dealing with Data* unit. So the box and whiskers plot came after the stem and leaf plot as the last statistical concept taught as part of this unit. Thus, the students had a strong understanding of mean, mode, median and range by the time box and whiskers was explored. The students used the *Dealing with Data* unit book's discovery technique and learned how to create the box and whiskers plot through answering my questions, some discussion and answering more questions. As demonstrated in the unit book, a number line was the starting point. Next, the data points were all plotted. Then using a counting method, students first split up the overall group of data points into two equal groups. Each of the two equal groups were then further split into two equal, smaller groups. This method created the four quartiles in a graphical and visual manner. The box and whiskers were added last.

I did not require written answers to all the questions from the unit book. Most of the questions were answered via discussions in small cooperative learning groups and as a class. The advantages and disadvantages of the plot were discussed along with inferences that could be made from this plot. In

addition to the in class work students created another box and whiskers plot for homework (see Exhibit II both the blank handout and the answer key, front and back) using a different group of data from the tornado statistics handout (see Exhibit I). The format of my homework handout came directly from the supplemental materials supplied by Paul Ridgeway during the *Dealing with Data* workshop.

4. **Observations**

My observations at this point were that students had difficulty on their own at home with the box and whiskers plot but very few problems with the stem and leaf plot. Specifically, the difficulties demonstrated were not with drawing the number line or plotting the data points. Instead, many students could not locate the three interior points needed to separate the four quartiles. Also, even when the students determined the three separating points, there were still problems understanding the significance of the point positions. The same students could not draw the box or the whiskers to complete the plot.

Due to the observed low level of mastery, the students did another box and whiskers plot in class. That was accompanied by further discussions emphasizing the three separation points as medians of the entire group first and then the newly created two halves next. At this point students were still creating the plot by drawing the number line, plotting the data points and counting the data points

visually on the number line to locate the separation points. As the in class work progressed, more students demonstrated a deeper understanding and ability to create the plot.

However, students still did not have complete mastery of the concept. This could be seen as a direct result of the assessment of this material (see Exhibit III both the assessment and answer key, front and back). The format of the assessment once again was built upon the supplemental materials handout supplied by Paul Ridgeway during the workshop and was in keeping with the style given previously as homework. The mean for this assessment was 78 with a range of 57 from 47 to 104. By far the most troublesome questions involved construction of a box and whiskers plot. Consequently, upon returning the assessment to the students, I spent extra time reviewing the box and whiskers plot. This time I took a different approach towards the method of constructing the plot. I began by drawing the appropriate number line for the data. Next, instead of plotting the data points on the number line, I shifted to the computational concept of median. I explained that another way to construct the plot was to compute the median of the data set and not count the plotted points until finding the middle one. Then, with the students' help the next two medians for both halves were computed. Now, these three medians and the two end points (the lowest and highest points of data) were plotted on the number line. From these five points the box and the whiskers were drawn onto the plot. The remaining data points were plotted next. The last thing discussed was the relationship between the two

end data points and the range. The class told me how since they already knew how to compute the range finding these two end points to plot was easy.

At this time I observed a totally different reaction from the students. Most notable were numerous comments like, “Oh! Why didn’t you show us this the first time before the test!”, “I see now. This is easy.”, “You should have told me this before I took the test and got it wrong.”, and “Now I can do this but I already took the test...can you give another test about this stuff?”. When I asked the students what the difference was now versus before the test the answers were the same from all five periods. They all agreed that computing the medians computationally was far easier than determining them graphically on the number line. I view this observation as the most significant from the entire *Dealing with Data* unit.

5. **Evaluation**

It was clear to me that the students achieved a more solid mastery of the box and whiskers plot concept through the computational approach noted above. Therefore, in the future when this concept is initially presented to the students I believe the computational approach based on their understanding of median should be utilized. The graphical approach of counting the plotted points on the number line should also be utilized, but as a two fold measure after the initial presentation. The first measure would be as a safety net means for any students

who might be more visual and graphic learners. These students might be unable to grasp easily the computational method. The second measure would be as a reinforcer to strength and deepen the students' level of understanding.

The reason for students' difficulty in understanding the visual and graphical approach to the box and whiskers plot in general I believe to be their lack of comfort in working with graphs. Although I have not researched this point, my own observations of my students indicates little knowledge of numerical axes graphs. Their comprehension of the workings of the graphs and what expectations they should have when dealing with graphs is very limited. I believe this could greatly influence the ability to achieve understanding through a graphical approach to box and whiskers plots.

When considering my own future classes and the requirement for the students to comprehend mean, mode, median, range, stem and leaf, and box and whiskers, I must first evaluate their needs. These future students will not come to my eighth grade classroom with the same set of math skills as my current students. The number one reason for this is that from next year onward, the eighth grade students will have studied math using the MiC series program for two years in sixth and seventh grades. In fact, they should have already studied the *Dealing with Data* unit. However, depending upon their needs I will be ready to teach/ review the concepts with them and follow the techniques I have stated within this paper.