The Statistics of Balancing

Subject(s): Mathematics (Algebra/Geometry Preparations, Applied Mathematics I, Applied Mathematics II, Algebra I, and Conceptual Mathematics)

Grade level(s): Grade 9, Grade 10, Grade 11, Grade 12

West Virginia CSO's: **Standard:** **Algebra and Technology:**

Objectives:

***. . . . MA.AGP.5.2** (WV - Algebra/Geometry Preparation:Objectives) Students will use data to determine mean median mode and range.
***. . . . MA.AM1.2.13** (WV - Applied Mathematics 1:Objectives) Students will collect organize interpret data to determine the mean mode median range and standard deviation.
***. . . . MA.A1.2.18** (WV - Algebra 1:Objectives) Students will collect organize interpret data to determine the mean mode median and range.
***. . . . MA.AM2.2.1** (WV - Applied Mathematics 2:Objectives) Students will analyze a given set of data for the existence of a pattern numerically algebraically and graphically; determine the domain and range; and determine if the relation is a function.
***. . . . MA.CM.5.5** (WV - Conceptual Mathematics:Objectives) Students will create and interpret data using various methods of displaying numerical data including frequency distributions graphs histograms stem-and-leaf plots and box-and-whiskers plots using technology when appropriate.
***....TEC.S.1: Basic Operations and Concepts.** (WV - K-12 Curriculum (TEC)) Students will: * demonstrate a sound understanding of the nature and operation of technology systems; and * demonstrate proficiency in the use of technology.
***. . . . . . TEC.9-12.1.1** (WV-k-12 Curriculum (TEC):Grade Nine-Twelve:Objectives) Students will use data input skills appropriate to the task.
***. . . . . . TEC.9-12.3.2** (WV - K-12 Curriculum (TEC):Grade Nine-Twelve:Objectives) Students will select and use appropriate technology tools to efficiently collect analyze and display data that is relevant to class assignments.
***....TEC.S.6: Technology Problem-solving and Decision-making Tools.** (WV - K-12 Curriculum (TEC)) Students will: * use technology resources for solving problems and making informed decisions; and * employ technology in the development of strategies for solving problems in the real world.

Performance Descriptors:

Distinguished: The student demonstrates exceptional and exemplary performance with distinctive and sophisticated application of knowledge and skills that exceeds the standard. The student interprets outcomes of collected data based on measures of central tendency and dispersion constructed graphs and simple events using rules of probability summarizing results in a clear concise manner.

Above Mastery: The student demonstrates competent and proficient performance and shows a thorough and effective application of knowledge and skills that exceeds the standard. The student predicts outcomes of collected data based on measures of central tendency and dispersion constructed graphs and simple events using rules of probability.

Mastery: The student demonstrates fundamental course or grade level knowledge and skills by showing consistent and accurate academic performance that meets the standard. The student calculates measures of central tendency and dispersion of collected data predicts outcomes of simple events using rules of probability and reads frequency distributions and line plots to solve simple problems.
Partial Mastery: The student demonstrates basic but inconsistent performance of fundamental knowledge and skills characterized by errors and/or omissions. Performance needs further development. The student calculates the mean and range of given data and reads line plots.
Novice: The student demonstrates substantial need for the development of fundamental knowledge and skills characterized by fragmented and incomplete performance. Performance needs considerable development.

This lesson has been designed to include the following basic instructional approaches & methods, adaptations and IEP provisions, assignments modifications, cooperative grouping, and behavioral management.

1. For students with disabilities, incorporate elements of effective practice, such as explicit strategy instruction, teacher modeling, guided and independent practice, monitoring of student performance, using a wide range of examples and non-examples, separating confusing terms, and cumulative reviews.
2. Provide lessons and activities that embed mathematics in real-life situations to foster student understanding of mathematics and promote generalization.
3. Integrate calculators within instruction via teacher-directed and discover-based approaches.
4. Individualize instruction through adjusted workload and modifications based on students' reading (e.g., reading to students) and writing (e.g., guided note taking, oral responses to questions) skills.
5. Use of cooperative group activities to promote positive social skills and concept/skill acquisition and retention.
6. Provide additional time for students to complete assignment.
7. Implement positive, pro-active, and consistent behavioral management strategies to improve students' effectiveness as members of a team in a school setting and increase the probability that students will be able to work effectively with others in work, leisure, family, and school activities.
8. Use structures worksheets or prompt cards to assist in organization and help students remember problem-solving steps/sub-steps.

Activity Type: Groups of 3 students for data collection
Whole group for calculator activity

Duration/length of the activity: 2 class periods

Material Needed: Stick-on notes
A clock/watch that measures seconds or a stopwatch
2 number lines (180 seconds) posted on wall
[Suggested 5-second bins]
Graphing calculator
A copy of the **Data Collection Guidelines** for each group

Prior Knowledge: Definitions of mean, median, mode, range, upper and lower quartile, minimum, maximum, standard deviation, histogram, and box-and-whiskers plot

Activity:

Divide the class into groups of 3 students. Each student will take turns being the timer, the judge, and the balancer. The timer should have his eyes on the clock before the person starts to balance. The judge must keep his eyes on the balancer at all times and will determine when the trial ends. The balancer will balance on each foot with his eyes closed. This activity should take a maximum of 20 minutes depending upon the balancing abilities of each group.

Use the dot plots to discuss the following questions with the students.

1. On which foot can people balance better?
2. Who is better at balancing, male or female?
3. What patterns do you notice in the data? Can you give an explanation for these patterns?
4. What is the mode of the data for each foot?
5. What is the median for the data for each foot?

Have the students to make a list of the data for each foot on a piece of paper. Use the calculator to find the mean for each foot by adding the numbers and dividing by the number of items.

All procedures listed below are for the TI – 83 graphing calculator

Have the students to use the graphing calculator to input the data into the lists. Use L_1 for one foot and L_2 for the other foot. Procedure for inputting data into a list is as follows:

- Press the Stat key
- Select Edit
- If the list has data entered, cursor up to list name and press Clear [**DO NOT PRESS DEL, THIS WILL DELETE THE WHOLE LIST]** then cursor down to the first line and enter the data. After the data has been entered into each list, press 2^{nd} Quit (mode) to exit.

Have the students to use the graphing calculator to find the statistical information (minimum, maximum, mean, median, and standard deviation) for each foot. The procedure for finding the statistical information is as follows:

- Press 2^{nd} List (stat)
- Cursor over to Math
- Choose the statistical information you want to find and press enter (you can also choose the information by just pressing the number you want)
- Enter the list you want to use $\rightarrow$ press 2^{nd} 1 for L_1 or 2^{nd} 2 for L_2 and then press enter

Although it is easier to find the mode without a calculator, you can use the calculator by sorting the list (if it was not put into the list in order) and viewing the lists to see which number occurs most often. The procedure for this is as follows:

- Press Stat
- Choose Sort A
- Enter the list you want to use and press enter. Then view the list. just as you would to enter a new list.

Use the graphing calculator to make a histogram of the data. The procedure for this is as follows:

- Press 2^{nd} Stat Plot (y =)
- Select Plot 1
- Turn the plot on
- Cursor down to the type and cursor over to histogram the press enter
- Input list name in the X List position
- Press Graph. If you can’t see the histogram, press Zoom and choose ZoomStat (#9)
- Tracing the graph will help you discuss some of the statistical information of histograms

Use the graphing calculator to make a box-and-whiskers plot. The procedure for this is as follows:

- Press 2^{nd} Stat Plot (y =)
- Select the plot you want to use. Either replace the histogram or turn it off.
- Be sure the plot you are using is turned on. Cursor down to the type and cursor over to box plot and press enter
- Input list name into the X List position
- Press graph. If you can't see the box plot, press Zoom and choose ZoomStat
- Tracing the graph will help you discuss some of the statistical information of box plots (minimum, lower quartile, median, upper quartile, and maximum)

Use the graphing calculator to find the 5 – number summary for each list. The procedure for this is as follows:

- Press Stat
- Cursor over to Calc
- Select 1-Var Stats
- Input list name and press enter. Cursor down to see all of the statistical information.

In addition to finding data with the balance activity, the following resources are available for data collection:

www.weather.com

www.nba.com

www.cdc.gov/nchs

www.census.gov

www.pbs.org

www.mathforum.org

illuminations.nctm.org

exploringdata.cqu.edu.au/

math.rice.edu

Data Collection Guidelines

The object of this activity is to record the length of time (in seconds) a person can balance on each foot with his eyes closed.

- Label a stick-on note as right foot and a stick-on note as left foot for each student in the group. Indicate if the student is male or female on each note, but do not put student names on these notes.

- The person can wiggle in place, but not hop or spin. Some part of the standing foot must always touch the floor.

- The foot that is up can't touch the floor, the wall, or furniture.

- If the person is still balancing at three minutes, stop the test and record three minutes as the time.

- The judge must keep his eyes on the person balancing at all times. When the trial ends, the judge must say, "Stop." Four things can end the trial:
  1. Person puts foot down.
  2. Person opens eyes.
  3. Person hops or touches an object or surface for balance.
  4. Person balances for three minutes.

- Allow the person to get comfortably balanced on one foot before closing eyes.

- Start timing when the person closes eyes and says, "Go." (The timer must have his eyes on the clock before the person says, "Go.") Stop timing when the judge says, "Stop."

- Immediately after each trial, use the correct stick-on note to record the length of time the person balanced.

- Place your recorded times on the correct number line to make a dot plot.

Adapted from *Bridges to Classroom Mathematics*