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| **Introduction** | | In these activities, students will explore the data that they gathered with Splash! and apply it to various mathematical tasks. |
| **Time** | | Approximately 90 minutes |
| **Grade** | | 9-12 |
| **Lesson**  **Preparation** | | Students will have visited the Tsongas Industrial History Center to participate in the Power to Production program. Students gathered data from the waterwheel test on the Splash! app.  The teacher should decide if the class will use the Sample Data spreadsheet (labeled data) or the Mystery Wheels spreadsheet (unlabeled data). Both files are available in .xlsx format with this lesson. Students can use either a graphing calculator or a computer to calculate. |
| **Vocabulary** | | Mean  Median  Standard Deviation  Interquartile Range |
| **Anticipated Student Preconceptions/ Misconceptions** | | Students should know the definitions of the terms mean, median, standard deviation, and interquartile range. This lesson will review the use of these statistics in describing a data set.  Students should have knowledge of different methods of representing data on a single variable. |
| **Frameworks** | | Massachusetts Math Standards  S-ID: Summarize, represent, and interpret data on a single count or measurement variable.  1. Represent data with plots on the real number line (dot plots, histograms, and box plots).[[1]](#footnote-1)★  2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets. ★  3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). ★ |
| **Guiding Question** | How can we use various statistics to describe the behavior of wheel/ base combinations? | | |
| **Objectives** | Students will be able to:   * Determine the mean, median, standard deviation and interquartile range for each of the eight data sets, using either Sample Data or Mystery Wheels spreadsheet. * Use the information from the Mystery Wheels spreadsheet and the data their class gathered at Splash! to determine which of the eight mystery wheels their assigned wheel matches to. | | |
| **Activity** | 1. Group students in teams of three or four 2. Show the data gathered at the site using the Splash! app. Remind students of the different types of wheel and base combination (red is bucket, blue is paddle). 3. Assign each group one of the wheel/base combinations collected on the field trip. Provide students with either the Sample Data or Mystery Wheels spreadsheet. 4. If students are using the Sample Data sheet:  * Students will determine the mean, median, mode, range and standard deviation for each set. * Students will determine if the data gathered on the field trip is outlier data, or if it is reasonable given other tests.  1. If students are using the Mystery Wheels sheet:  * Students need to match their wheel/ base combination with one of the Mystery Wheels. * Students should be able to present their results to the class and justify their match using statistics. | | |
| **Assessment** | Assessment will be done through student presentations, either written or oral. | | |
| **Differentiated**  **Suggestions** | Differentiation based on time: Use only the odd numbered columns (speed data), or only four of the eight wheel/ base combinations. The original excel file contains a teacher sheet with information about which data were collected from which wheel.  For ELL students, consider providing sentence frames “I know \_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_.” “I agree with \_\_\_\_\_ because \_\_\_\_\_\_.” “I disagree with \_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_.” | | |
| **Adapting the Activity for Other Grades** | For students preparing for the MCAS test, the questions could be presented in a four part “long answer” style model, using only one of the sets of data. For example, given the column A data set   1. Find the range of the data. 2. Find the lower bound, median, upper bound of the data set. 3. Create a box and whisker chart to represent the data set. 4. The testers determined that the speed measurement of 15 was inaccurate. If this data point is removed, how would the box and whisker chart change?   Other ideas include dividing students into teams of two or four students – one student or pair creates a line plot from one column of data, then challenges the other student or pair to find mean, median, mode and range from the line plot. | | |

**Sample Data**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Bucket Base A Speed** | **Bucket**  **Base A Strength** | **Bucket Base B Speed** | **Bucket Base B Strength** | **Bucket**  **Base C Speed** | **Bucket Base C Strength** | **Bucket Base D Speed** | **Bucket Base D Strength** | **Paddle Base A Speed** | **Paddle Base A Strength** | **Paddle Base B Speed** | **Paddle Base B Strength** | **Paddle Base C Speed** | **Paddle Base C**  **Strength** | **Paddle Base D**  **Speed** | **Paddle Base D Strength** |
| 5 | 0 | 9.5 | 7 | 11 | 3 | 8 | 3 | 3.5 | 0 | 8 | 5 | 8.5 | 1 | 7.5 | 2 |
| 4 | 0 | 8 | 5 | 10 | 4 | 9 |  | 3 | 0 | 7 | 5 | 9 | 2 | 8 | 3 |
| 5 | 0 | 11 | 4 | 11 | 4 | 9 | 3 | 7 | 0 | 10 | 2 | 8 | 2 | 10 | 2 |
| 0 | 0 | 9 | 3 | 11 | 5 | 8 | 4 | 3 | 0 | 7 | 3 | 7 | 2 | 8 | 1 |
| 3 | 0 | 9 | 6 | 11 | 6 | 8 | 8 | 0 | 0 | 7 | 5 | 10 | 2 | 8 | 2 |
| 6 | 1 | 10 | 3 | 6 | 3 | 9 | 4 | 6 | 0 | 11 | 3 | 7 | 4 | 8 | 3 |
| 5 | 0 | 8 | 5 | 11 | 3 | 8 | 3 | 4 | 0 | 8 | 3 | 8 | 1 | 7 | 2 |
| 7 | 0 | 8 | 4 | 4 | 5 | 5 | 5 | 5 | 0 | 5 | 6 | 4 | 0 | 9 | 2 |
| 5 | 0 | 9 | 4 | 9 | 3 | 4 | 4 | 6 | 0 | 8 | 7 | 5 | 0 | 7 | 3 |
| 4 | 0 | 10 | 4 | 9 | 3 | 8 | 3 | 6 | 0 | 5 | 5 | 2 | 3 | 8 | 1 |
| 4 | 0 | 9 | 3 | 11 | 4 | 8 | 1 | 4 | 0 | 5 | 5 | 6 | 2 | 8 | 0 |
| 4 | 0 | 10 | 3 | 8 | 3 | 10 | 3 | 5 | 0 | 5 | 5 | 11 | 2 | 8 | 1 |
| 4 | 0 | 7 | 1 | 11 | 4 | 8 | 1 | 6 | 0 | 5 | 5 | 9 | 2 | 8 | 0 |
| 7 | 1 | 10 | 5 | 12 | 4 | 9 | 5 | 6 | 0 | 8 | 4 | 6 | 3 | 8 | 5 |
| 7 | 0 | 9 | 4 | 10 | 3 | 4 | 2 | 5 | 0 | 7 | 3 | 4 | 4 | 9 | 2 |
| 4 | 0 | 5 | 2 | 8 | 6 | 8 | 8 | 8 | 0 | 9 | 7 | 5 | 0 | 9 | 4 |
| 15 | 0 | 6 | 2 | 15 | 8 | 15 | 4 | 14 | 0 | 15 | 6 | 13 | 3 | 10 |  |
| 6 | 0 | 9 | 4 | 12 | 7 | 7 | 4 | 8 | 0 | 7 | 5 | 5 | 2 | 9 | 3 |
| 8 | 0 | 9 | 4 | 16 | 8 | 5 | 2 | 7 | 0 | 8 | 6 | 11 | 3 | 7 | 6 |
| 6 | 1 | 5 | 2 | 13 | 6 | 5 | 2 | 7 | 1 | 7 | 2 | 8 | 2 | 8 | 2 |

**Mystery Data**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Wheel Base1 Speed** | **Wheel**  **Base1 Strength** | **Wheel**  **Base2 Speed** | **Wheel**  **Base2 Strength** | **Wheel**  **Base3 Speed** | **Wheel**  **Base3 Strength** | **Wheel**  **Base4 Speed** | **Wheel**  **Base4 Strength** | **Wheel**  **Base5 Speed** | **Wheel**  **Base5 Strength** | **Wheel**  **Base6 Speed** | **Wheel**  **Base6**  **Strength** | **Wheel**  **Base7 Speed** | **Wheel**  **Base7 Strength** | **Wheel**  **Base8 Speed** | **Wheel**  **Base8 Strength** |
| 5 | 0 | 9.5 | 7 | 11 | 3 | 8 | 3 | 3.5 | 0 | 8 | 5 | 8.5 | 1 | 7.5 | 2 |
| 4 | 0 | 8 | 5 | 10 | 4 | 9 |  | 3 | 0 | 7 | 5 | 9 | 2 | 8 | 3 |
| 5 | 0 | 11 | 4 | 11 | 4 | 9 | 3 | 7 | 0 | 10 | 2 | 8 | 2 | 10 | 2 |
| 0 | 0 | 9 | 3 | 11 | 5 | 8 | 4 | 3 | 0 | 7 | 3 | 7 | 2 | 8 | 1 |
| 3 | 0 | 9 | 6 | 11 | 6 | 8 | 8 | 0 | 0 | 7 | 5 | 10 | 2 | 8 | 2 |
| 6 | 1 | 10 | 3 | 6 | 3 | 9 | 4 | 6 | 0 | 11 | 3 | 7 | 4 | 8 | 3 |
| 5 | 0 | 8 | 5 | 11 | 3 | 8 | 3 | 4 | 0 | 8 | 3 | 8 | 1 | 7 | 2 |
| 7 | 0 | 8 | 4 | 4 | 5 | 5 | 5 | 5 | 0 | 5 | 6 | 4 | 0 | 9 | 2 |
| 5 | 0 | 9 | 4 | 9 | 3 | 4 | 4 | 6 | 0 | 8 | 7 | 5 | 0 | 7 | 3 |
| 4 | 0 | 10 | 4 | 9 | 3 | 8 | 3 | 6 | 0 | 5 | 5 | 2 | 3 | 8 | 1 |
| 4 | 0 | 9 | 3 | 11 | 4 | 8 | 1 | 4 | 0 | 5 | 5 | 6 | 2 | 8 | 0 |
| 4 | 0 | 10 | 3 | 8 | 3 | 10 | 3 | 5 | 0 | 5 | 5 | 11 | 2 | 8 | 1 |
| 4 | 0 | 7 | 1 | 11 | 4 | 8 | 1 | 6 | 0 | 5 | 5 | 9 | 2 | 8 | 0 |
| 7 | 1 | 10 | 5 | 12 | 4 | 9 | 5 | 6 | 0 | 8 | 4 | 6 | 3 | 8 | 5 |
| 7 | 0 | 9 | 4 | 10 | 3 | 4 | 2 | 5 | 0 | 7 | 3 | 4 | 4 | 9 | 2 |
| 4 | 0 | 5 | 2 | 8 | 6 | 8 | 8 | 8 | 0 | 9 | 7 | 5 | 0 | 9 | 4 |
| 15 | 0 | 6 | 2 | 15 | 8 | 15 | 4 | 14 | 0 | 15 | 6 | 13 | 3 | 10 |  |
| 6 | 0 | 9 | 4 | 12 | 7 | 7 | 4 | 8 | 0 | 7 | 5 | 5 | 2 | 9 | 3 |
| 8 | 0 | 9 | 4 | 16 | 8 | 5 | 2 | 7 | 0 | 8 | 6 | 11 | 3 | 7 | 6 |
| 6 | 1 | 5 | 2 | 13 | 6 | 5 | 2 | 7 | 1 | 7 | 2 | 8 | 2 | 8 | 2 |

1. ★ Indicates modeling standard. [↑](#footnote-ref-1)