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| Date: Summer 2021 | Duration of Lesson: 1 day |
| Title of Unit: Data Analysis | Title of Lesson: An Introduction to Box-and-Whisker Plots |
| Essential Question: What is a box-and-whisker plot, and how can it be used to represent a set of data? |
| Learning Concepts: Students will be able to understand how to collect, organize and arrange data on a number line and display on a box whisker plot for analyzing. |
| Learning Objectives: Collect, organize and arrange data on a number line and display on a box whisker plot for analyzing. |
| Learning Objectives: 1.  Review vocabulary related to data analysis and connect it to box-and-whisker plots. 2.  Interpret and explain the elements of box-and-whisker plots and how to create one using a targeted data set. |
| Groupings (e.g., whole class, small groups, co-teaching): Whole Class |
| Skills & Standards: [CCSS.MATH.CONTENT.6.SP.B.4](http://www.corestandards.org/Math/Content/6/SP/B/4/)Display numerical data in plots on a number line, including dot plots, histograms, and box plots.[CCSS.MATH.CONTENT.6.SP.B.5.C](http://www.corestandards.org/Math/Content/6/SP/B/5/c/)Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. |
| **Progression of Learning & Teaching** |
| Opener: | Math Yapper (from John Sangiovanni’s *Daily Routines to Jump-Start Math Class*): Either partner students up or have each student locate their own partner.  Have them sit/stand facing each other so that one’s back is to the board.  Put the words histogram, mode, and maximum on the board.  The partner who can see the board needs to pick one of the words and give the other person clues until they are able to guess the vocabulary term.  If they have time, have them provide clues for the second and third word as well.  After each partner has had a chance to guess at least one of the words, have them switch roles.  Repeat the activity using the words mean, dot plot, and minimum.Have students return to their seats and brainstorm to list real world scenarios in which one might examine a set of statistical data.  Discuss these as a class and have students vote on one to use for some quick research.  Give them a few minutes to find a sample set of data related to the selected topic. | **Points to Remember** |
| Activities & Tasks: | The following lesson is adapted from an NCTM Classroom resource entitled “Alphabet Soup” by Grace M. Burton. 1. Use a set of data from the context students chose during the opener if possible.  Give each student an index card and have them write a number from that data set on it.  \*Not all students have to receive a card if there are not enough data points.  Volunteers could be given cards representing the data while the rest of the class works to determine the minimum, maximum, median, lower quartile and upper quartile values. Option: If there are not enough data values and you want all students to have a card with a value, students could write the number of letters in their name (or values from another data set) instead on their index card.
2. Have students line up at the front of the room such that the numbers on their cards are in order from least to greatest.  Tip: Use masking tape or painter’s tape on the floor to create a numberline and more visual box-and-whisker plot in addition to drawing it on the board as they identify the minimum, maximum, median, lower quartile, and upper quartile values during the following portion of the lesson.  They will not really be able to see this during the creation, but once they sit down, it will help them make connections between their human box -and-whisker plot and the one drawn on the board for them to see.
3. Ask students what the minimum and maximum value are; reinforce each term in doing so.  Be sure and discuss or have students describe what these values mean in the context of the data set.  Draw a number line on the board, and plot both values above it.  Then, draw a line connecting these two points.
4. Ask the first and last student in line to sit down simultaneously and continue doing so until only one or two students are left standing.
5. Ask students what they notice about the location of the student(s) left standing (the student/students were in the middle of the line).
	1. If only one student is standing, ask if each student in line was a data point, which vocabulary term the standing student would represent? (the median).
	2. If two students were standing, tell students each person in line represents a data point and ask what the middle data point is called (the median).  Then, challenge them to find the median for the set of data they represent.
	3. Label the median above the line on the board for students to see.  Ask them what the median means based on the context of their data.
6. Have all students with cards whose value less than or equal to the median (but not the median itself) stand up.  Pose the following - “If these were the only data points, what would the median be?”  Once students identify it and explain their reasoning, plot the point above the line on the board but do not label it yet.  Repeat this process with the values higher than or equal to (but not the median itself), and plot the point above the line.
7. Spread the line out such that there is space between each section created by each of the “medians” students identified.  Ask them whether there is anything they notice.  Guide them to the realization that each section has the same number of students.  Have one section stand up, and ask the class what fraction of the data is represented.  If they say one-fourth, remind them that a fourth can also be referred to as one-quarter of the data.  Label the data point on the board between the minimum value and the actual median “lower quartile.”  Label the data point between the actual median and the maximum value “upper quartile.”  Help students make the connection that one-fourth of the numbers in the data set are below the lower quartile, between the lower quartile and the median, between the median and the upper quartile, and above the upper quartile.
8. Draw a box from the lower quartile to the upper quartile with a line through it at the median of the data.  Ask students to explain why the median is not the middle of the line itself or the center of the box (unless the data set is distributed such that it is).
9. Have students return to their seats.  Inform them that the representation on the board is called a box-and-whisker plot.  Point out the box and whiskers.  Ask them what information it reveals based on the context of their data and discuss why it may be a useful representation.
10. Discuss the “box” portion as well as the “whisker” portion of the plot including the fractional portion of the data values each portion represents.

Practice/Application:1. Display the following link and have students access it on their devices: [Boxplot Game](https://www.geogebra.org/m/uDvj56NC#material/FysUaDQE).  Have students complete and submit the first example.  Stop them for discussion.  Allow them to make observations and ask questions.  Be sure to discuss the minimum, lower quartile, median, upper quartile, and maximum values.
2. Give students a chance to do the second problem in their notebooks or on a personal whiteboard with a neighbor or those sitting near them before asking them to share their strategies with the class.
3. Have them try the third problem by themselves and then check with a partner before discussing it as a class.  Repeat with the fourth example or have them complete the fourth and fifth both independently based on the understanding they have demonstrated throughout the discourse.
 | Resources: Original version of this lesson may be accessed by NCTM members at <https://www.nctm.org/Classroom-Resources/Illuminations/Lessons/Alphabet-Soup/> Boxplot Game may be accessed at <https://www.geogebra.org/m/uDvj56NC#material/FysUaDQE>Key Vocabulary: data set, box-and-whisker plot, minimum, lower quartile, median, upper quartile, maximumMonitoring/Scaffolding/Differentiation/SDI:Constantly connect back to the context of the data values to help students conceptualize the vocabulary.The number line itself should be evenly spaced and the values from the data should be *accurately* spaced when placed on the line above it that will form the box-and-whisker plot based upon their distribution rather than *evenly* spaced regardless of their values.Some students may be confused when the median is not in the center of the number line on the board. Make it a point to discuss/clarify this misconception as it arises.Students may struggle to understand how to spread out.  It may be best to tell them where to leave gaps in the line.  When done correctly, there will be the same number of students within each section.Connecting to the idea that there are four quarters in one whole dollar may help students remember one-fourth is equivalent to one-quarter.Be sure and take the time to help students make the connection between their human box-and-whisker plot and the one drawn on the board.Do not prioritize “correctness” during these discussions.  The game is self-checking. Focus on the concepts and strategies being utilized.  |
| Level of Cognitive Complexity: | [x]  Creating[ ]  Evaluating [x]  Analyzing | [x]  Applying[x]  Understanding[x]  Remembering |
| Key questions: | 1. What are real world scenarios in which one might examine a set of statistical data?
2. What does the median mean in the context of the data set?
3. What does the minimum mean in the context of the data set?
4. What does the maximum mean in the context of the data set?
5. What does the lower quartile mean in the context of the data set?
6. What does the upper quartile mean in the context of the data set?
7. What fraction of data values are represented by the whiskers on a box plot?
8. What fraction of data values are represented by the box portion of the box plot?
9. What is a box and whisker plot, and how can it be used to represent a set of data?
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| Closure: | Quick Write:  Explain how a box-and-whisker plot represents a set of data.  Be sure and incorporate the vocabulary used to refer to each element (minimum, lower quartile, median, upper quartile, maximum). |
| Next Steps: | * Have students continue working with box-and-whisker plots in context until they have mastered the vocabulary and are able to create as well as interpret them.  Potential resource for NCTM Members: “Using NBA Statistics for Box-and-Whisker Plots.”  It can be accessed at <https://www.nctm.org/Classroom-Resources/Illuminations/Lessons/Using-NBA-Statistics-for-Box-and-Whisker-Plots/>.
* Adjust data sets, and have students investigate and explain how changing one or more values impacts the appearance of a box-and-whisker plot.  Be sure and connect back to the context of the data whenever possible.
* Provide students with an opportunity to compare and contrast box-and-whisker plots created from different data sets representing a single context. Discuss the different distributions and shapes of each box-and-whisker plot and what those variations mean in context.
* Provide students with opportunities to compare and contrast different types of data representations including dot plots and histograms.  In doing so, encourage students to make generalizations about when each representation might be beneficial.
 | **Formative Assessment Criteria for Success:** 1. Students give accurate clues during the opener as well as use their partner’s clues to determine the vocabulary terms.2. Students list real world situations that involve examining statistical data during the brainstorming portion of the opener.3. Discussion and answers to key questions should reflect conceptual understanding throughout the lesson.4. Students describe or explain what the vocabulary terms refer to in context of the data set. 5. Students manipulate the elements of the box-and-whisker plot during the Boxplot Game to represent the data values during step 13 of the lesson.6. Students explain each element of a box-and-whisker plot when completing the Quick Write during the closure. |