Developing Proficiency in Grade 6 Common Core Statistics

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Introduction

- Students have difficulty finding and interpreting the mean, median, and other statistical measures of center appropriately (Zawojewski & Shaughnessy, 2000).

- **Purpose:** explore and develop students' thinking about graphical representations of data and finding appropriate measures of center

How can students' proficiency in regard to Grade 6 Common Core Mathematics Standards about statistical measures of center be developed?

Theoretical Framework

We used the *Adding it Up* framework to conceptualize mathematical proficiency. It includes the following five strands:

- *Conceptual understanding*
- *Procedural fluency*
- *Strategic competence*
- *Adaptive reasoning*
- *Productive disposition*

CCSSM Learning Progressions for Statistics

The Common Core State Standards Writing team (2011) described key transitions and competencies in learning statistics in accordance with the Common Core State Standards in a learning progressions document.

Key ideas:

- Begin with a statistical question
- Displaying data in dot plots
- Characterization of data distributions by measures of center
- Using their knowledge of division, fractions, and decimals in computing a new measure of center—the *arithmetic mean*, often simply called the *mean*

Additional Guiding Concepts from Literature

Groth & Bargagliotti (2012) explained how to engage all students in statistical investigation using the Common Core:

1. Formulating Questions
2. Collecting Data
3. Analyzing Data
4. Interpreting Results

In addition to finding, using, and interpreting measures of center, we focused on helping students understand the mean's relationship to other measures of center, such as median and mode.

Methodology

Participants

- **Time Frame:** Ten weeks
- **# Of Participants:** Four students & two teachers
- **Participation Rate:** 100%
- Seven weekly **one-hour sessions** in addition to **pre and post assessment interviews.**
- For the privacy of the students, the following pseudonyms will be used: *Cody, Flynn, Millie, Giselle*

Procedures

CCSS Instructional Goals:

- Understand that a set of data collected to answer a statistical question has a distribution which can be *described by its center, spread, and overall shape*
- Recognize that a *measure of center* for a numerical data set summarizes all of its values with a *single number*
- Display numerical data in plots on a number line, including *dot plots*, histograms, and box plots. as well as *describing any overall pattern*
- Relating the choice of *measures of center* and variability to the *shape of the data distribution* and the context in which the data were gathered

Methodology

Data Gathering & Analysis

1. Two cameras record entire hour session

2. Playback video & transcribe each word spoken, as well as any emotions/movements

3. Find strengths & weaknesses in students' learning in terms of the 5 Strands of Mathematical Proficiency

4. Make data-based conjectures about how to foster students' learning

5. These conjectures = basis for developing following week's lesson

Gathered written and video recorded data from interaction with the four students

Analyzed the data from the four students

Established student learning goals based on assessment of data

Posed selected task to the four students in a classroom setting to forward their thinking

Initial Assessment Results

Overall most of the students lacked *conceptual understanding* when it came to **finding typical values** and when it comes to **comparing statistical measures**. For an example in this problem below most students chose the median for Theater A and the mean for Theater B.

This question requires you to show your work and explain your reasoning. You may use drawings, words, and numbers in your explanation. Your answer should be clear enough so that another person could read it and understand your thinking. It is important that you show *all* of your work.

The table below shows the daily attendance at two movie theaters for 5 days and the mean (average) and the median attendance.
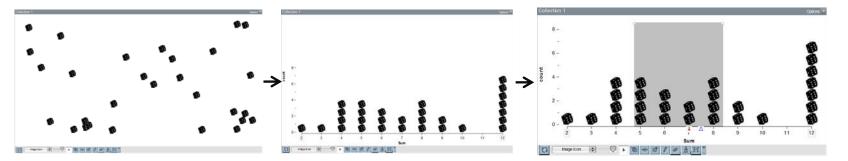
	Theater A	Theater B
Day 1	100	72
Day 2	87	97
Day 3	90	70
Day 4	10	71
Day 5	91	100
Mean (average)	75.6	82
Median	90	72

(a) Which statistic, the mean or the median, would you use to describe the typical daily attendance for the 5 days at Theater A? Justify your answer.
(b) Which statistic, the mean or the median, would you use to describe the typical daily attendance for the 5 days at Theater B? Justify your answer.

Displaying Data (Week 2, 3, 4)

Lesson Formats:

- Students generated data from rolling dice
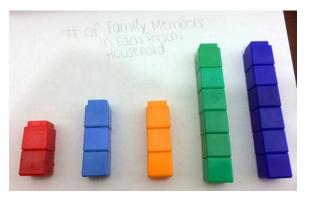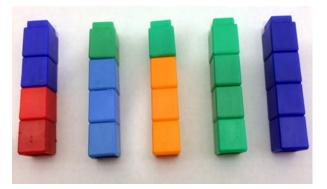- Represented data using dot plots (*conceptual understanding*)

- Organized & compared multiple data sets
- Identified middle clump (*strategic competence*)
- Discovered method for finding the middle data value (median) by crossing off values from each side of the graph (*procedural fluency*)

Understanding Mean (Week 5, 6)

Lesson Formats:

- Discussed differences in the shapes of graphs
- Described how each statistical measure (mean, median, mode) is affected with various data
- Students understood mean as a number that "evens out" or "balances" a distribution → used snap cubes as data values

- By redistributing the snap cubes (or family members) they could easily see how the mean represented a "fair share" for the data set

Measures of Center (Week 7, 8)

Lesson Formats:

- Presented skewed data sets to students

- <u>Example</u>: 24 Starburst candy distributed unevenly amongst four students & two teachers

  - Asked to find the average or typical number of candies that each person received: **1, 1, 1, 1, 1, 19**

- During the final lesson, students analyzed a data set showing salaries of individuals in a small town:

Some of the candidates are confused about "average." Slugville has only 16 residents, and their weekly incomes are $0, $0, $0, $0, $0, $0, $0, $0, $200, $200, $200, $200, $200, $200, $200, and $30,600.

Example

Some of the candidates are confused about "average." Slugville has only 16 residents, and their weekly incomes are $0, $0, $0, $0, $0, $0, $0, $0, $200, $200, $200, $200, $200, $200, $200, $200, and $30,600.

a. Explain which measure of center each of the candidates used as an "average" income for the town. Check their computations.

e. What do you consider to be the typical income for a resident of Slugville? Explain.

EH: So with the doctor being out what do you think the typical income is?

Flynn: 0

Millie: Even the doctor made them fall.

KK: Why do you think 0?

Giselle: Because it is the mode.

KK: Okay. So do you think the median is still a good representation because that just changed? Do you think that is still good?

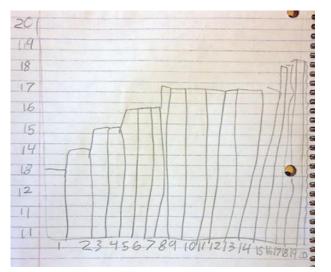Millie: Yeah because he carry's the paper and he gets $200 for it.

Giselle: The firefighters don't get anything for it and he saves lives and houses.

Dr. Groth: The stop sign guy don't look to happy because he got 200 and you're saying that the average is 0. He doesn't like that.
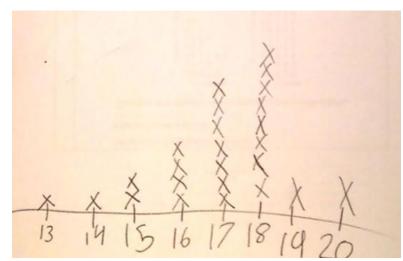
Post Assessment Results

Overall students gained *conceptual understanding* when it came to finding the best statistical measure to represent a typical value. Students gained *procedural fluency* and *strategic competence* in selecting and constructing data displays. These aggregated displays helped them locate the centers of data sets.

Initial Assessment

Post Assessment

Reflection

- Helped students begin to reason conceptually about measures of center, but did not have time to delve into formal measures of variability (also prescribed in the Sixth-Grade Common Core)
- Challenges:
  - Achieving every CCSSM Standard for Grade 6 Statistics is
  - Connecting how changing some of the data could affect the measures of center
  - Switching back and forth between dot plots and case value bars
- **Suggestion**: Begin to develop these ideas before sixth grade

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