# Use Your Shoe![1]

Each student will contribute to the class shoe size data, collect data for the entire class, and analyze the data by determining the mean, median and mode. Students will use their analyses to make inferences about the average shoe size of larger populations.

**Suggested Grade Range:** 6-8

**Approximate Time:** 2 hours

**State of California Content Standards:**

> Mathematics Content Standards Grade 8: Probability and Statistics
> *10.0 Students know the definitions of the* mean, median, *and* mode *of distribution of data and can compute each of them in particular situations.*

> Science Content Standards Grades 6-8:  Investigation and Experimentation
> *7. b. Students will use appropriate tools and technology to perform tests, collect data, and display data.*
> *9. b. Students will evaluate the reproducibility of data.*

**Relevant National Content Standards:**

> Mathematics Common Core State Standard: 7.SP
> *2. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest.  Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions.  Gauge how far off the estimate or prediction might be.*

**Lesson Content Objectives:**
- Distinguish among and calculate the mean, median and mode of a data set.
- Collect and organize data from the group.
- Calculate the mean, median and mode of the group data.
- Draw inferences about a population after examining the group's sample.
- Practice calculating the mean, median and mode for data from different contexts.

**Materials Needed:**
- One copy per student of the "Mean, Median, and Mode" notes sheet, "Use Your Shoe!" activity sheet, and "Independent Practice" sheet (included)
- One shoe card per student to record their shoe size (included)
- Tape

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[1] *An early version of this lesson was adapted and field-tested by Alex Chao and Thy Pech, participants in the California State University, Long Beach Foundational Level Mathematics/General Science Credential Program.*

**Summary of Lesson Sequence**

- Provide the "Warm Up" activity sheet (included) for students to practice using the correct order of operations to evaluate multi-step expressions.
- Introduce the lesson by allowing students to find out the shoe size of five other students in the class and discussing how that data could be used to make a guess about the shoe size for the whole class.
- Lead students through the "Mean, Median, and Mode: Guided Notes" (included) by modeling how to find these measures of central tendency.
- Allow all students to contribute their shoe sizes by taping each student's shoe card to the board on a frequency chart. Guide students through their own practice of finding the mean, median and mode for the entire class using the data on the board and the "Use Your Shoe!: Guided Practice" activity sheet (included).
- Check for students' understanding by asking the key questions provided while students are working on the guided practice.
- Close the lesson with a discussion of their findings and how their findings could be extended to larger populations.
- Provide the "Independent Practice" sheet for students to practice finding the mean, median and mode for data in different contexts.

**Assumed Prior Knowledge**

Prior to this lesson students should be able to use the correct order of operations to evaluate multi-step expressions.

**Classroom Set Up**

Students will be asked to participate in discussions and work in small groups for portions of this lesson.

**Lesson Description**

Introduction

Provide students with the "Warm Up" activity, allowing them time to practice using the correct order of operations to evaluate multi-step expressions. Students should be able to complete the warm up on their own.

Provide every student with a pre-cut square with a picture of a shoe on it. Students should write their shoe size on the square. Allow students a couple of minutes to move around the room and share shoe sizes with four other students, (each student write down their own size and the shoe size of four peers so all will have 5 data points). They can record the other students' shoe sizes on the back of their own shoe card. After about two minutes, ask students to find their seats again to begin a brief discussion. Ask:

*Based on the data you collected from four other students and yourself, what do you think is the most common shoe size in the classroom?*

*What shoe size do you think is right in the middle of the biggest and smallest?*

*Can you hypothesize from the five shoe sizes that you know what the average shoe size for the whole class might be?*

Tell students that they will be learning how to analyze data using three measures of central tendency: mean, median and mode. Make sure your discussion arrives at classroom understanding of working definitions for these terms.

Input and Model

Provide students with the "Mean, Median, and Mode: Guided Notes" sheet and review the definitions for mean, median and mode:

| | | |
|---|---|---|
| **Mean: average** | **The mean is the sum of all values divided by the number of values in the data set.** | Demonstrate for students the method for calculating the mean by adding up all the shoe sizes of the sample set and dividing by the number of students in the sample set. Encourage students to find the mean of their sample of five students' shoe sizes that they collected. Allow students to notice that their answers may vary because they collected data from different students. This can lead to a conversation about larger sample sizes being more representative of the entire group. |
| **Median: middle** | **The median is the middle value of the data set when the data set is ordered least to greatest.** | Model for students the method for finding the *median* of the sample data by organizing the sample set as a list from least to greatest and finding the middle shoe size. Encourage students to find the median of their sample of five students' shoe sizes that they collected. Discuss how they would find the median if their data had an even number of data points (e.g., 6 shoe sizes). |
| **Mode: most** | **The mode is the most frequently occurring value of the data set.** | Model for students the method for finding the *mode* of the sample data by observing which shoe size occurs most frequently in the sample set. Explain that data sets might not have a mode or might have more than one mode; ask volunteers to provide examples of data sets that have no or multiple modes. Students should recognize whether there is a mode for the sample of five shoe sizes and identify the mode if there is one. |

Show students how to create a frequency chart for the sample set of data.
Model for students the second sample set of data for the number of text messages sent.

Guide Students Through Their Practice

Draw an outline of a frequency chart on the board for the whole class' shoe size data; an example frequency chart outline is on the students' "Guided Notes." Allow students to come to the board and tape their shoe card above the number value for their shoe size, vertically stacking repeated values to create a bar graph.

Students should use the data on the board to complete the "Use Your Shoe!: Guided Practice" activity sheet.

Students may work together to complete the guided practice.

Check for Understanding

Check for students' understanding while they are working on the guided practice by asking the following key questions:

*Are the mean, median and mode for the whole class different from the mean median and mode you found from the set of five that you collected?*

*Why might they be the same or different?*

*Each measure of central tendency tells us something different about the data. What does the mean tell us? The median? Mode?*

*Which measure of central tendency do you think is helpful for understanding this particular shoe data? Why?*

Independent Practice

Provide students with the "Independent Practice" sheet to complete on their own.

Closure

To close the lesson, allow students to share their findings about the mean, median, and mode for the whole class. Ask students:

*Was the sample of five shoe sizes helpful for guessing the mean, median, and mode for the whole class?*

*Do you think we could use our findings for the whole class to guess the shoe size of a larger population?* [Other classes of the same age, the whole school, all children of the same age around the world, all Americans, etc.]

*To what extent is the data we collected today reproducible by another class here at our school?*

**Suggestions for Differentiation and Extension**

- This activity may be extended by allowing students to develop their own survey, collect data outside of the classroom, and summarize and analyze the data using the measures of central tendency they learned in this lesson.
- If working with the same group of students over a period of time, students could be asked to explain what they learned in the days following the activity in a journal, or as a warm-up.
- Students may conduct research using the Internet to determine whether the shoe size data for the classroom is representative of larger populations.
- Depending on the class, students' heights may be collected instead of shoe size to provide more variability.
- Students may use graphing calculators to calculate the mean, median and mode for the shoe size data, as well as for the independent practice problems. Students may also use graphing calculators to create frequency tables for the sets of data.

# Use Your Shoe!

1. Simplify:
   $$\frac{2 + 3 + 4 + 5 + 6 + 7}{6} =$$

2. Simplify:
   $$2(4) + 4(3) + 2(7) =$$

3. $$\frac{(4 \times 6) + (2 \times 3)}{9} =$$

4. $$11 \times 6 + 6 \times 3 + 2 \times 2 =$$

5. $$4567 \div 22 =$$

# Mean, Median, and Mode
Guided Notes

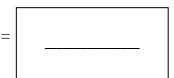1. Create a frequency chart for this sample set of shoes sizes: 6, 10, 9, 8, 8, 6, 12, 14, 9, and 8.

| Student # | Shoe Size |
|-----------|-----------|
| A | 6 |
| B | 10 |
| C | 9 |
| D | 8 |
| E | 8 |
| F | 6 |
| G | 12 |
| H | 14 |
| I | 9 |
| J | 8 |

_____

Shoe Size

**Find:**

A.    **Mean:** add all shoe sizes and divide by total number of students.

| $\dfrac{\text{Sum of all shoe sizes}}{\text{Total number of students}}$ | $=$ | ─────────── | $=$ | |
|---|---|---|---|---|

B.  **Median:** write all shoe sizes in order from least to greatest and find the middle shoe size.

| | | | | ◯ | ◯ | | | | |
|--|--|--|--|--|--|--|--|--|--|

   If there are two middle shoe sizes, add those two sizes and divide by 2

| $\dfrac{\quad + \quad}{2}$ | $=$ | |
|---|---|---|

C.  **Mode:** find the shoe size that occurs the most.    [ ]

*Use Your Shoe!*

2. Second sample: Last week, Jane sent 34 text messages, John sent 25, Sofia sent 41, Priscilla sent 12, Cisco sent 33, Fred sent 24, and Riley sent 25.

| Name | # Of messages sent |
|------|--------------------|
|      |                    |
|      |                    |
|      |                    |
|      |                    |
|      |                    |
|      |                    |
|      |                    |

_____

Total Number of Texts

**Find:**
    A. **Mean:** add all text messages and divide by the number of students.

| Total text messages / Total number of students | = | _____ | = | |

    B. **Median:** write all numbers of messages sent from least amount to greatest and find the middle data point.

| | | | | ◯ | ◯ | | | | |

If there are two data points in the middle, add them and divide by 2.

| ___ + ___ / 2 | = | |

    C. **Mode:** find the amount of messages sent that occurs most frequently.

*Use Your Shoe!*

# Use Your Shoe!
Guided Practice

Review vocabulary: mean, median, mode.
**A. Mean** is the sum of all values divided by the number of values in the data set. Another term used for mean is *average*.
**B. Median** is the middle value in the data set. If there are two middle values, add them and divide by two.
**C. Mode** is the most frequently occurring value data point of the set.

| Student | Shoe Size | Gender |
|---------|-----------|--------|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |

Shoe Size

Mean (add all shoe sizes / total # of students) = _____

$$\frac{\text{Add all shoe sizes}}{\text{Total \# of students}} = \boxed{\quad\underline{\quad\quad}\quad} \quad\boxed{\quad}$$

Median (write all shoe sizes in order from least to greatest, find the middle shoe size. If there are two middle shoe sizes, add them up and divide by 2) = _____

Mode (find the shoe size that occurs most frequently) = _____

# Mean, Median, and Mode
## Independent Practice

Practice finding the mean of a data set by calculating the Grade Point Average (GPA) using the sample report card provided. First read the "Report Card Information," then use the data from the "Sample Student Report Card" to find the GPA.

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**Report Card Information**

**Honor Roll**

Honor Roll is determined by grade point average (GPA).

| Honor Roll: | 3.0 -3.5 |
|---|---|
| High Honor Roll: | 3.6 -3.9 |
| Highest Honors: | 4.0 - 4.3 |

**Grades (with Numerical Value)**

High schools use the table below for determining Grade Point Averages and Rank in Class:

| A+ = 4.3 | B+ = 3.3 | C+ = 2.3 | |
|---|---|---|---|
| A = 4.0 | B = 3.0 | C = 2.0 | D = 1.0 |
| A- = 3.7 | B- = 2.7 | C- = 1.7 | F = 0.0 |

*Grade points corresponding to letter grades for students in AP Courses (who take the AP Exam) are 0.3 units higher.*

*\*\*\*For example a student in an AP Course would receive 3.6 points for a B+ instead of 3.3. An F for these students remains at 0 points.*

*\*\*\*When calculating the GPA, the letter grade's numerical value is multiplied by the units to determine the weighted grade points. These are totaled and divided by the total units in that marking period. The following example illustrates the calculation of a GPA for a student with no AP Courses using the grade point table above:*
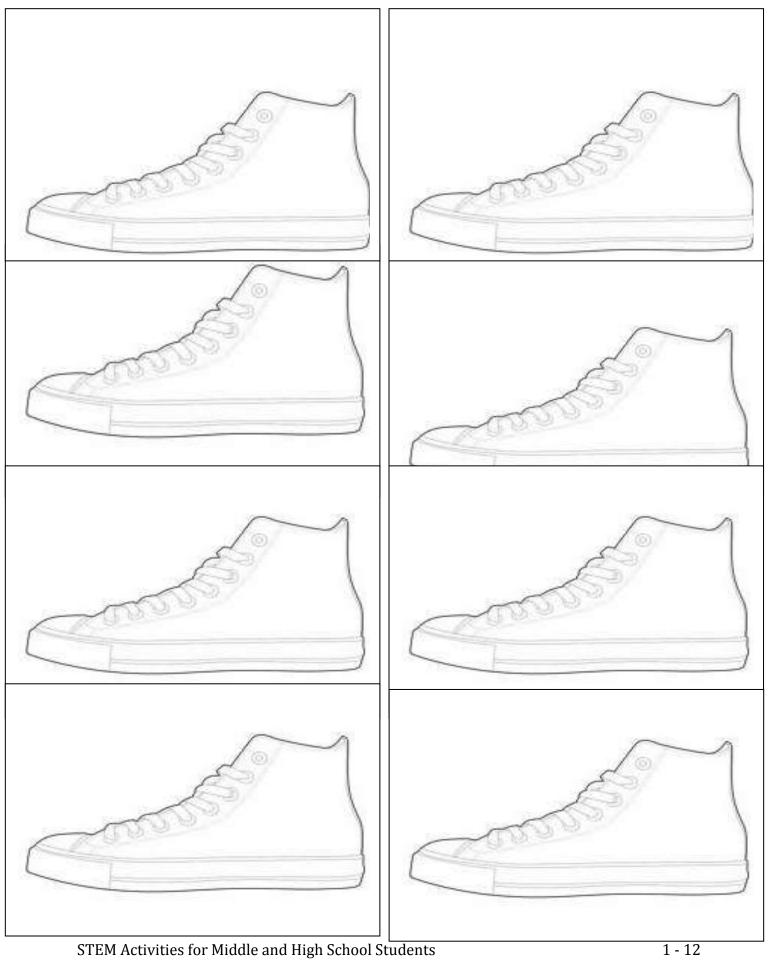
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**Sample Student Report Card**

| Units | Course | Letter Grade | Numerical Value | Grade Points |
|-------|--------|--------------|-----------------|--------------|
| 1 | A.P. English | B+ | 3.3 | 3.6 |
| 1 | Math | A- | 3.7 | 3.7 |
| 1 | Science | A | 4 | 4 |
| 1 | Social Studies | C | 2 | 2 |
| 1 | Computer | D | 1 | 1 |
| *.50 | PE | P | 0 | 0 |
| .50 | Orchestra | A | 4 | 2 |

*PE is not counted in the divisor because of the Pass/Fail status of the course. Therefore, you DO NOT include it in your calculations of GPA.*

**All courses that are graded pass/fail are not considered in GPA (ex. College Seminar, Teaching Assistant, etc.).*

1. Use the sample report card above to calculate the weighted GPA.

2. Based on the GPA you calculated, would a student with this report card earn any honors?

*Use Your Shoe!*

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