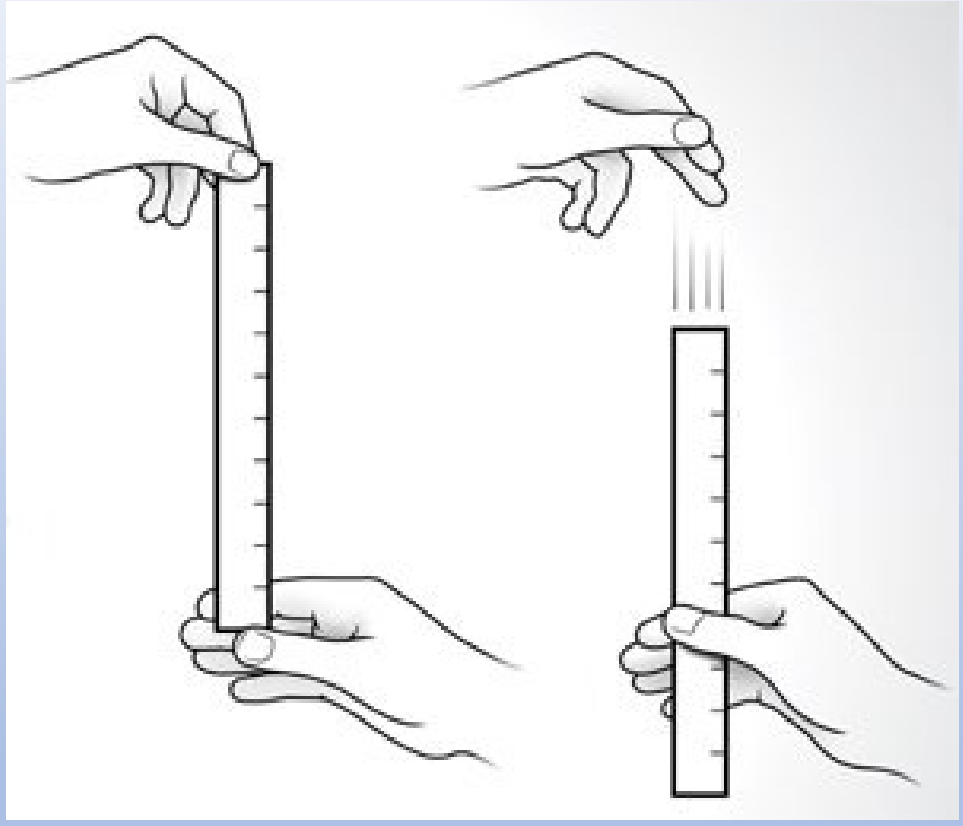
WEST VIRGINIA
DEPARTMENT OF EDUCATION



MATHEMATICS

Algebra I

Analyzing Data

Table of Contents

Task Title: Analyzing Data
Grade or Content Area: 9th grade, Algebra I
Toolkit Author: Natalie Dillinger and Adam Riazi
Original Task Creator: Illustrative Mathematics
Quarter: 1

Rationale for Lesson and Associated Tasks

Students in 9th grade (Math I or Algebra I) determine a statistical question testing the reaction time when dropping and catching a ruler under 2 different conditions. The distance the ruler falls provides the data for this experiment. This task invites students to design an experiment to answer a statistical question. Students collect and analyze data using one variable statistics. Students determine the shape, center, and variability for the collected data. Students also interpret the results to answer the statistical question. There is no one correct set of data or analysis for this task. The focus is on the collection and interpretation of the data and identifying appropriate measures for center and variability based on the shape of the data. Discussions are built-in to this task to foster an environment of collaboration, active thinking, and listening.

Lesson and Associated Tasks Overview

Preparation: (click here)
Lesson: (click here)
Practice: (click here)
Student Lesson: (click here)
Student Practice: (click here)

For grade 9 students, this lesson and associated tasks may serve as a culmination for collecting and analyzing data for one-variable statistics. Students design a statistical question that will be answered through the data analysis. Students need to focus on the interpretation of the shape of the graph and the measures of center and variability as they answer the statistical question.

This lesson and associated tasks are scheduled to be completed over 3 class periods per the suggested sequence.

Day 1

1. Review center and variability using DESMOS activity builder: Statistics: Shape, Center, and Spread of Data
2. Introduce "Analyzing Data". Provide students with rulers and *Statistical Analysis* Handout
3. View the *Ruler Drop Demonstration* with students
4. Determine conditions for ruler drop data collection
5. Collect data for ruler drop
6. Create a graphical display for each set of data

Day 2

1. Gallery Walk using I notice…. wonder protocol.
2. Introduce finding measures of center and variability using data collected on Day 1
3. Calculate the measure of center and variability for both data sets
4. Answer statistical question providing data analysis to support the answer
5. Students share results with small groups of 6 or 8 students

Day 3

1. Students share findings from Day 2 (small groups of 6 or 8 students).
2. Collect data collection using class generated questions.

3. Individual assessment: Find the center and spread for the class generated question.
4. Working in small groups, complete Practice 1 from *Analyzing Data*

West Virginia College- and Career-Readiness State Standard

M.1HS.31 (Math I) or M.A1HS.33 (Algebra I)
Represent data with plots on the real number line (dot plots, histograms, and box plots).

M.1HS.32 (Math I) or M.A1HS.34 (Algebra I)
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**. Instructional Note: In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points.

M.1HS.33 (Math I) or M.A1HS.35 (Algebra I)
Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers). Instructional Note: In grades 6 – 8, students describe center and spread in a data distribution. Here they choose a summary statistic appropriate to the characteristics of the data distribution, such as the shape of the distribution or the existence of extreme data points.

Mathematical Habits of Mind (MHM)

MHM1. Make sense of problems and persevere in solving them.
MHM3. Construct viable arguments and critique the reasoning of others.
MHM5. Use appropriate tools strategically.
MHM6. Attend to precision.

Mathematics Teaching Practices to Support Student Growth

- Implement tasks that promote reasoning and problem-solving.
- Use and connect mathematical representations.
- Pose purposeful questions.
- Support productive struggle in learning mathematics.
- Elicit and use evidence of student thinking.

Essential Understandings

- A statistical question can be answered by **collecting data** from a specified population with variability within the data.
- The **center and variability** (spread) for data sets can be determined based on the shape of the data.
- Through **comparison and analysis** of the measures of center and variability, the statistical question can be answered.

Set-up Phase

1. **Become an Expert Regarding All Lesson and Associated Task Content**
   The teacher must become familiar with all "*Analyzing Data*" materials. This lesson comes with many associated tasks, the use of each may vary depending on the time frame available for the lesson and

student levels of engagement and understanding. Reviewing, analyzing, and completing all tasks before the implementation with students is imperative for classroom success.

2. Establish Small Groups

The "*Analyzing Data"* tasks promote both individual and partner thinking. While working with a partner, students will create a statistical question. They will collect and analyze data to answer the statistical question. Students will explore the meaning of data analysis for shape, center, and spread of one variable statistics. Students will contribute to a meaningful small group (combined small groups of 6 or 8 students) conversations regarding the meaning of their analysis as it relates to the statistical question.

Skill levels, leadership skills, and personalities are all considered when creating small groups (partners and during later tasks, groups of 6 – 8 students). Small group collaboration works best when students have been provided with previous opportunities to work together regularly. Weeks of teacher observation of student behavior will be extremely helpful when creating small groups for this lesson and associated tasks. Taking notes regarding leadership skills, personalities, the ability to take criticism, to question, and to think deeply about a task or problem will enable teachers to make sound decisions regarding small group placement.

When creating the groups, all these factors help to eliminate the potential situation in which one student takes the lead and makes the decisions for the group. In this scenario, one student is gaining all the benefits of the task, while others do not. If a student is not engaged in conversation, this lesson and associated tasks will not be beneficial in helping all students to have a meaningful discussion about the mathematics involved nor in analyzing the relationships inherent to the tasks. Students will be working both individually and together when placed in small groups to complete this lesson and associated tasks.

3. Develop Open-Ended Questions

- What are the conditions for data collection?
- What is the method for data collection?
- What problems do you foresee during data collection?
- How many trials are needed for each condition?
- Is the graph for the data symmetric, uniform, or skewed in shape?
- How did you choose which measure of center and which measure of variability to use?
- Using the context of both data collections, how do the values for center affect the analysis of the data?
- Using the context of both conditions, what did the measure of variability tell you about the data?
- How did you answer your statistical question?
- Imagine that you collected data from the entire class, how would this change how you displayed or analyzed your data?

4. Gather Materials

- Computer and presentation devise (required for teacher usage)
- Internet access (test all videos before student implementation)
- Calculators (one per student)
- Videos (online): *Ruler Drop Demonstration*
- Rulers

- DESMOS App downloaded on teacher and student (optional) computers
- DESMOS activity builder Statistics: Shape, Center, and Spread downloaded on teacher computer as well as student (optional) computers
- Chart paper (grid paper)
- Markers
- Statistical Analysis handout (1 copy provided for each small group)

5. Anticipated Common Student Misconceptions

- Students may not create an open-ended statistical question.
- Students may not read a ruler correctly.
- Students may not use the distribution shape correctly to determine the measure of the center.
- Students may not use the appropriate center of the spread. For example, they may use the mean but have outliers, so the median is more appropriate.
- Students may computer the interquartile range inappropriately.
- Students may not interpret the measure of variability correctly.

Explore Phase

Before the teaching of this lesson and associated activities, the following content should be covered in previous lessons or as reviews.

1. Graph data collections using various methods including dot plot, stem and leaf plot, and histograms.
2. Find the measure of the center using mean and median.
3. Find the measure of variability using interquartile range or standard deviation.
4. Based on the shape of the graph, determine if the data is uniform, symmetric, or skewed.
5. Determine the appropriate measure of center and variability based on the shape of the graph.
6. DESMOS activity builder Statistics: Shape, Center, and spread of data as a final review of concepts before the activity. (Click here)
   See teacher notes for Day 1 for suggestions when using DESMOS.

Prior Instruction/Knowledge:

In grades six through eight, students learn to describe data distributions using shape, center, and spread. In Algebra I, students build on their understanding allowing them to give more precise answers for deeper questions and to make comparisons between data sets.

Please review the following:

Educators Guide for Mathematics: Algebra 1 (pages 37 – 41, pdf 39 – 43) (Click here)
Educators Guide for Mathematics: Math 1 (pages 32 – 36, pdf 34 – 38) (Click here)

Prerequisite Skills

- Organize, display, and interpret information in tables and graphs (frequency tables, pictographs, and line plots).
- Describe data using or selecting the appropriate measure of central tendency: choose a measure of central tendency based on the shape of the data distribution.
- Use frequency tables, dot plots, and other graphs to determine the shape, center, and spread of a distribution.

Supporting Skills

- Organize, display, and interpret information in bar graphs.
- Describe data using the mode.
- Organize, display, and interpret information in line graphs.
- Describe how the mean, frequency distribution, and interquartile range of data affects its graph.

Impending Skills

- Use frequency tables, dot plots, and other graphs to determine the shape, center, and spread of data distribution.
- Identify and use appropriate scales and intervals in graphs and data displays.
- Define and use the normal distribution curve to model a set of data: estimate the area under the curve.

Source: *The Quantile Framework for Mathematics*
https://metametricsinc.com/educators/quantile-for-educators/
2020 MetaMetrics Inc.

Implementation Phase

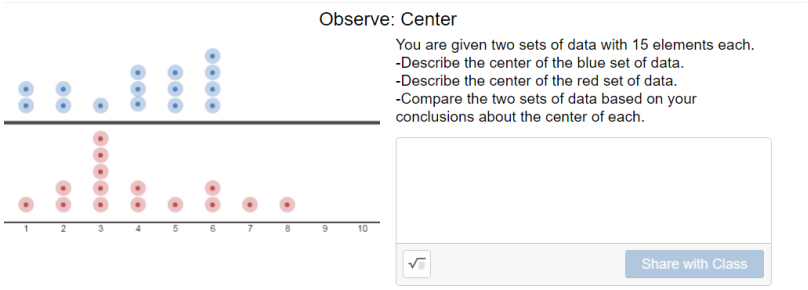
Day 1

- Review measures of center and variability using DESMOS activity builder: Statistics: Shape, Center, and Spread of Data
- Introduce "Analyzing Data". Provide students with rulers and *Statistical Analysis* Handout
- View the *Ruler Drop Demonstration* with students
- Determine conditions for ruler drop data collection
- Collect data for ruler drop
- Create a graphical display for each set of data

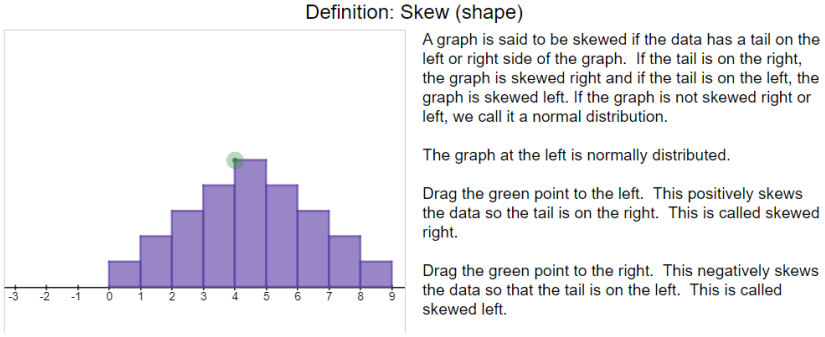
Day 1 Teacher Notes:

1. As a whole group, complete slides 2, 6 -7, 10 -11 from the DESMOS activity builder Statistics: Shape, Center, and Spread of Data. (click here)

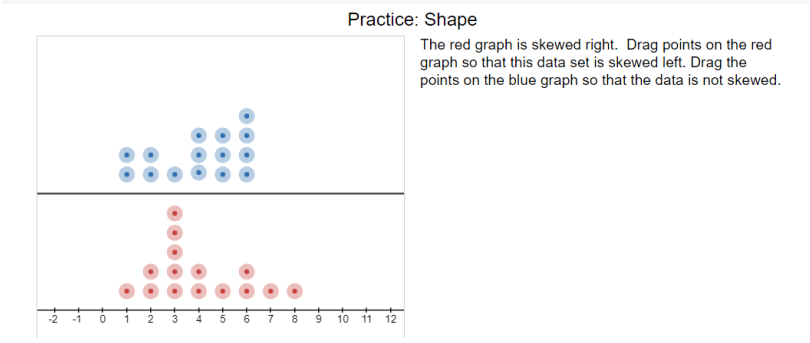
Slide 2



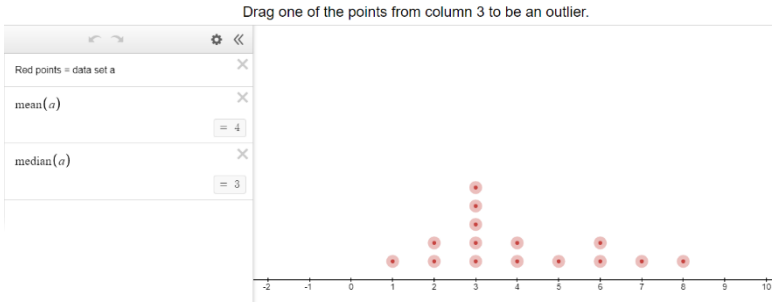
Slide 6



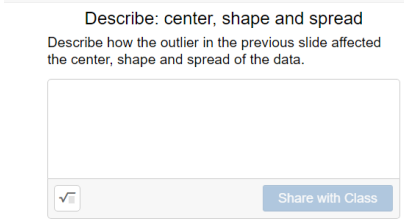
Slide 7



Slide 10



Slide 11

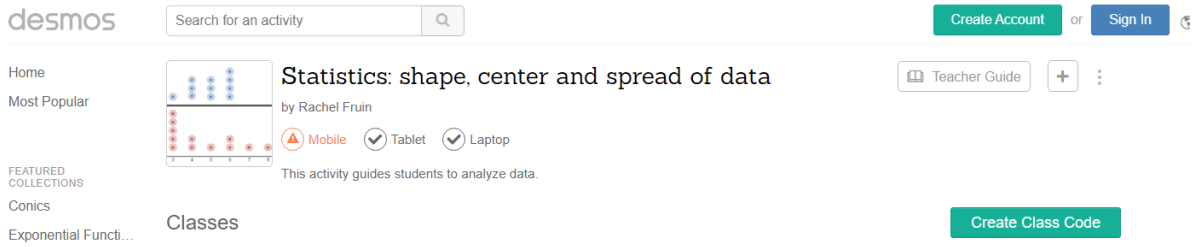


DESMOS is a free app that can be downloaded by both teachers and students. This activity can be completed as a teacher-led whole-class discussion using a projector. If students have computer access, this activity can be completed individually or in small groups, allowing for increased student engagement.

To prepare DESMOS activity:

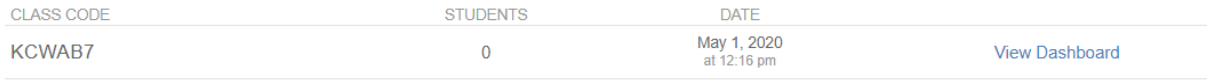
Open DESMOS: (click here)

Create an account (for the teacher)

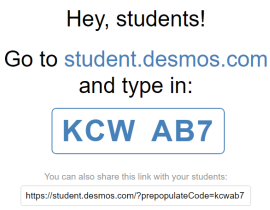


Create a class code

Click on the class code (Each class code is different).



Students open DESMOS students using the information provided by the Class Code.



- Students can complete this activity with or without a student account.
- The teacher dashboard provides additional options to use while completing the activity including: anonymize screens so students are not identified as they answer; pause class allows the teacher to halt student work when needed; pacing allows the teacher to determine screen range for student work; and the teacher can project a screen for discussion.

Other portions of the activity builder can be used as preparation for *Analyzing Data*.

2. Introduce activity *Analyzing Data*
   Provide each group of 2 students a ruler and a copy *of Statistical Analysis* to use to record data. Teacher explanation for the purpose of the activity: to pose and answer a statistical question by designing an experiment, collecting data, and analyzing data when a student drops a ruler and another student catches the ruler.
3. Students view the video *Ruler Drop Demonstration*. (click here)
   One person holds the ruler at the 12-inch mark, and the other person will hold their thumb and forefinger open on either side of the flat side of the ruler at the 0-inch mark. The person holding the ruler will drop the ruler and the other person should close their fingers as soon as they notice the ruler moving to catch it. The distance the ruler falls should be used as the data for this experiment.
4. Working in groups of 2, students determine a statistical question for dropping and catching a ruler under 2 different conditions. For example: Statistical equation using 2 different conditions. How does standing vs sitting affect how far the ruler drops before being caught?

As students determine their statistical questions and conditions for collecting data, circulate the room. The following are examples of questions to ask students as they are working:

- Is the statistical question open-ended?
- How will data be collected?
- What are some problems that may occur during data collection?
- How many trials will be needed for each condition?

5. Working in groups of 2, students collect data for each condition. Record data on *Statistical Analysis* handout. Before the implementation of *Analyzing Data*, create a student handout, *Statistical Analysis,* for students to use throughout the activity. The handout should contain the following information:

- Statistical Question;
- Data from Collection 1;
- Data from Collection 2;
- The measure of Center for Collection 1;
- The measure of Center for Collection 2;
- The measure of Variability for Collection 1;
- The measure of Variability for Collection 2;
- The Answer for Statistical question with supporting analysis.

6. Working in groups of 2, students create a graphical display for the data from each data collection. Include statistical questions at the top of the chart. Leave room for analysis of data and answer to the statistical question.

7. Students discuss the shape of the data for each condition using the following questions: Is the graph of either data set skewed right or left? Is the graph of the data symmetric? Is the graph of the data uniform in shape. How many peaks does the graph show? Make note of small groups that chose similar statistical questions. At the end of Day 2, students meet in groups of 6 or 8 (created by the teacher based on statistical questions) and compare results from the data analysis.

Day 2

- Gallery Walk using I notice…. wonder protocol.
- Introduce finding measures of center and variability using data collected on Day 1
- Calculate the measure of center and variability for both data sets
- Answer statistical question providing data analysis to support the answer
- Students share results with small groups of 6 or 8 students

Day 2 Teacher Notes:

1. Before the gallery walk, review with students the following questions regarding the shape of the data graphs for both collections of data: Is the graph skewed, uniform, or symmetric? How many peaks do you see? Do the graphs for both data sets have similar shapes?

2. Students complete the Gallery Walk for the graphs and data collections created on Day 1. Students utilize the I notice… wonder protocol for 3 different groups in the class. Teachers assign groups ensuring all displays receive comments.

3. As whole group students discuss notices and wonderings regarding data graphs. Limit the gallery walk and discussion to 15 minutes.

4. Introduce finding measures of center and variability (spread) using data collected on Day 1. As part of a whole group discussion, answer the following questions:

- What does it mean for the data to be skewed?
- What is the best method for finding the center, if the data is skewed?

- What is the best method for finding the center, if the data is symmetric or uniform?
- If the mean is the center of the spread, what is the method for finding the variability?
- If the median is the center of the spread, what is the method for finding the variability?

5. Working in groups of 2, students find the measures of center and variability for both data collections. As students work, circulate among the groups to determine student understanding and identify any misconceptions groups may have regarding the process of finding the center and variability for their data. Use the questions in #4 as a guide when working with the small groups. If a group is incorrectly finding a measure of center or variability, refrain from doing the problem for them. Use the following as a guide for correcting errors in formula or computation:
- Describe how to compute the mean.
- Describe how to compute the median.
- What values are needed for the interquartile range?
- Describe the process for finding the standard deviation.
- Explain what you did to find the measure for the center or variability.

6. As a whole-class discussion, students discuss the following before answering the group statistical question. Using the context of both data collections, how do the values for center affect the analysis of the data? Using the context of both data collections, how do the measures of variability affect the analysis of the data?

7. Working in small groups, students compare measures found for center and variability for each data collection. Using the context of both data collections, answer the statistical question determined on Day 1, providing data analysis to support the answer. Record findings on the *Statistical Analysis* handout. As students answer the statistical question, use the following to guide small group discussions:
- How did you determine the answer to the statistical question?
- Have you explained the reasoning for the answer to the statistical question based on measures of center and variability?
- How did you choose which measure of center and which measure of variability to use?
- Using the context of both conditions, what did the measure of variability tell you about the data?

8. Students check answers for the center and spread using technology. Provide students with calculators to verify the answers for measures of center and variability. If graphing calculators or software is available, students also verify the graphs for the data.

9. Students record information on the group chart, including: Measures for center and variability, Answer and justification for the statistical question.

10. Working together in pre-determined groups of 6 or 8, students share findings from their statistical questions. Encourage students to ask questions regarding the mathematical thinking or design approach used when creating charts. Students prepare to share at least 3 findings with the entire class (Day 3). Post the following questions for students to ask in this group:
- How did you choose the measures of center and which variability measure to use?
- How did you answer the statistical question?
- Using the context of the two data collections, explain the meaning of the measure of variability.
- Summarize at least 3 findings from this larger group (6 – 8 students) to be shared with the class.

Day 3

- Students share findings from Day 2 (small groups of 6 or 8 students).

- Collect data using a class generated question.
- Individual assessment: Find the measures of center and spread for the class generated question.
- Working in small groups, complete Practice 1 from "*Analyzing Data"*

Day 3 Teacher Notes:

1. Students summarize overall findings from small groups (6 – 8 students) with the entire class.

2. As a whole-class discussion, students choose an open-ended question to use for data collection for the individual assessment. For example, How many hours do you study each week?
Write the question on the whiteboard and have students answer while the teacher (or another student records results).

3. Working individually using the data collected in #2:

- Record data;
- Determine the appropriate method to find a measure of center;
- Find the measure of center for the data;
- Determine the appropriate method to find the measure of variability;
- Find the measure of variability;
- Analyze the results from the measures of center and variability values.

The above questions can be projected for students or given to each student individually as a handout.

4. Working in small groups, students complete practice questions in "Analyzing Data". (click here)

Share, Discuss and Analyze Phase

Essential Understanding #1:

*A statistical question can be answered by **collecting data** from a specified population with variability within the data.*

Share – Students are given the task of designing a statistical question for dropping and catching a ruler under 2 different conditions. After students view *Ruler Drop Demonstration* (video), students discuss in small groups at least 3 different sets of conditions that could be used for the data collection. For example: standing and sitting when catching the ruler.

Discuss – Working in small groups students discuss the following questions as they create the statistical question for their small group and prepare for data collection: Is the statistical question open-ended? How will data be collected? What are some problems that may occur during data collection? How many trials will be needed for each condition? How will the data be displayed (after collection)?

Analyze – Working in small groups students create a graphical display of their data using both conditions. Students discuss the shape of the data for each condition: Is the graph of either data set skewed right or left? Is the graph of the data symmetric? Is the graph of the data uniform in shape? How many peaks does the graph show?

Essential Understanding #2:

*The **center and variability** (spread) for data sets can be determined based on the shape of the data.*

Discuss – Students complete notice and wonders during a gallery walk of student graphs. Each group of students finds a notice and wonder, using the following questions, from 3 other small groups:

- Is the graph skewed, uniform, or symmetric?
- How many peaks do you see?
- Do the graphs for both data sets have similar shapes?

Share – Students discuss as a whole group the following questions to determine the appropriate center and variability measure to use for their data sets.

- How does a graph that is symmetric or uniform differ from a graph that is skewed?
- What is the best method for finding the center, if the data is skewed?
- What is the best method for finding the center, if the data is symmetric or uniform?
- If the mean is the center of the spread, what is the method for finding the variability?
- If the median is the center of the spread, what is the method for finding the variability?

Analyze – Students working in small groups find the measures of center and spread (variability) for each data collection based on the shape of the graph.

Essential Understanding #3:

*Through **comparison and analysis** of the measures of center and variability, the statistical question can be answered.*

Share – As a whole-class discussion, students answer the following before answering the statistical question for the small group:

- Using the context of both data collections, how do the values for center affect the analysis of the data?
- Using the context of both data collections, how do the measures of variability affect the analysis of the data?

Discuss – Working in small groups, students answer the statistical question by comparing the measures of center and variability for the data collections.

Analyze – In combined small groups of 6 or 8 students, share findings from statistical questions. Students answer the following questions in this group: How did you choose the measures of center and which variability measure to use? How did you answer the statistical question? Using the context of the two data collections, explain the meaning of the measure of variability. Summarize at least 3 findings for this group to be shared with the class.