

Teacher Guide: Reaction Time 1



Learning Objectives

Students will...

- Read and interpret data on a list, table, bar graph, and dot plot.
- Determine basic statistics including range, mode, and median of a data set.
- Compare data sets from related experiments.
- Draw conclusions based on data.



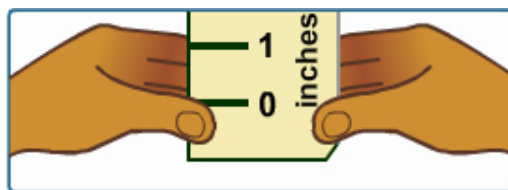
Vocabulary

bar graph, data, dot plot, median, mode, range



Lesson Overview

In a well-known experiment, one person holds a ruler vertically, and another tries to catch the ruler when it is dropped. The faster the catch, the smaller the number on the ruler will be. The *Reaction Time 1* Gizmo™ allows students to try this experiment and several others in a controlled environment.



How quickly can you catch the ruler?

The *Reaction Time 1* activity focuses on range, mode, and median of a data set. The *Reaction Time 2* activity uses the same Gizmo and focuses on mean.

The Student Exploration sheet for *Reaction Time 1* contains three activities:

- Activity A – Students run the **Click the target** experiment in the Gizmo and find the mode of their data. They also test the effect of having a moving target to click.
- Activity B – Students run the **Catch the ruler** experiment in the Gizmo and find the median of their data. They compare their reflexes to sight vs. sound stimuli.
- Activity C – Students choose an experiment and collect data for their right and left hands. Students compare results by finding the medians of even-numbered data sets.



Suggested Lesson Sequence

1. **Pre-Gizmo activity** (🕒 10 – 20 minutes)
Introduce the *Reaction Time 1* Gizmo by trying the falling ruler experiment. Several of the **Selected Web Resources** include instructions for this activity. One student holds a yardstick vertically and drops it, and another student catches the yardstick as quickly as possible after it's dropped. To prevent students from cheating, instruct the catchers to stare straight ahead at the ruler, rather than at the hands of the person holding the ruler. Another way to “cheat” is to drop your hand as you catch the ruler. Prevent this by having the catcher rest his or her arm on a desk or table.

Once you have gathered data for each student, discuss how you would compare results for each student. Would you compare best scores, average score, or their most common score? This discussion will prepare students for the statistics presented in the Gizmo.

2. **Prior to using the Gizmo** (🧠 10 – 15 minutes)

Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class. At this point, letting students share how they thought about the questions is more valuable than “going over” the correct answers. After the discussion, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations.

3. **Gizmo activity** (🧠 15 – 20 minutes per activity)

Assign students to computers. Students can work individually or in small groups. Have students work part of the Student Exploration sheet using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Extending the Gizmo** (🧠 15 – 20 minutes each)

Here are some suggestions for extending the activities in the Student Exploration sheet.

Activity A Extension – In this activity and in the warm-up activity, students find the mode and range of a data set and look at different ways of presenting the same data. On a projector, demonstrate how mode and range “look” in the unordered list, ordered list, table, bar graph and dot plot. Which of these displays is best at visually showing the mode and range of the data set?

Activity B Extension – In this activity, students find the median of data sets with odd numbers of values. First, discuss why median can be a fairer way to describe a data set than mode. In the bar graph given at the beginning of the activity, most of the data points are greater than the mode. For non-symmetrical data sets, the median is a better indicator of the middle of the data set. Have students practice finding the median of odd-numbered data sets.

Activity C Extension – Practice finding the median of other even-numbered data sets. Ask students, what is the median of a data set like 1, 4, 4, 6, where the two middle values are the same? (The answer is that the median is simply equal to that value, in this case 4.)

In addition, discuss how the median is shown on each of the graphical displays available in the Gizmo. While mode and range are shown very nicely on the dot plot and bar graph, the best way to “see” the median is in a simple ordered list.

5. **Follow-up activity: Is there a difference?** (🧠 30 – 60 minutes)

Encourage students (or groups) to design their own experiment of reaction time. For example, students can compare the reaction times of 5th graders to the reaction times of 1st graders. Or they could compare the reaction times of boys to girls, or of video game players to non video game players. Students can also test reaction times at different times of the day, or after eating different foods.

As students design their experiments, emphasize the importance of creating a fair, or *controlled* experiment. For example, if you were comparing the reaction times of boys to girls, it would not be fair to test the boys with sound on and girls with no sound.

Help students present their results with graphs and statistics. Keep all the raw data so that students can calculate means after doing the *Reaction Time 2* activity.



Scientific Background

In our bodies, the nervous system is responsible for detecting and responding to external stimuli. *Sensory neurons* in the skin, ears, eyes, nose and tongue detect tactile, auditory, visual, olfactory, and taste stimuli. Impulses are transmitted to the brain, where they are processed. Signals are sent through *motor neurons* to the muscles, which then respond to the stimulus.

In the case of a reflex, the response to the stimulus occurs automatically, without conscious thought. For some reflexes, the brain isn't involved at all! For example, when your leg is tapped just below the knee, the nerve signal goes to the spinal cord, where the response is then routed directly to the motor nerves in your quadriceps, causing your leg to kick.

Reaction time tests have been used for many years by experimental psychologists. Most studies indicate that people have reaction time of about 0.2 seconds for visual stimuli, and a faster reaction time (about 0.15 seconds) for sound stimuli. This difference relates to the length of the nerves connecting the eyes and ears to the visual and auditory centers of the brain. (The visual center is located at the back of the brain.)

Distance	Reaction time
5 inches	0.16 sec
10 inches	0.23 sec
15 inches	0.28 sec
20 inches	0.32 sec
25 inches	0.36 sec
30 inches	0.39 sec
35 inches	0.42 sec

The chart at right shows how to find reaction times based on distance. (To be exact, $t = \sqrt{0.00514 \cdot d}$, where t is time in seconds, and d is distance in inches.)



Mathematical Background

One of the goals of both of the *Reaction Time Gizmos* is to help students analyze and present data. Four numbers, or *statistics*, are commonly used to describe a data set – *range*, *mode*, *median*, and *mean*. The first three are covered in the *Reaction Time 1* activity, and the mean is the focus of the *Reaction Time 2* activity.

The range of a data set is the difference between the highest value and the lowest. Consider the data set (15, 13, 17, 13, 11, 15, 14). The highest value is 17, and the lowest is 11. Therefore the range is the difference between those two values: $17 - 11 = 6$.

The mode is the most common value in a data set. For example, in the data set (1, 2, 3, 2, 5) the mode is 2 because 2 occurs twice. Sometimes a data set can have multiple modes. For example, the data set (15, 13, 17, 13, 11, 15, 14) has two modes: 13 and 15. If each value occurs the same number of times, there is no mode.

The median is the middle value in the data set when the values are ordered from least to greatest. To find the median of the data set (15, 13, 17, 13, 11, 15, 14), first order the numbers: 11, 13, 13, 14, 15, 15, 17. The middle number of the ordered list, 14, is the median.



Selected Web Resources

Reaction Time 2 Gizmo: <http://www.explorelearning.com/gizmo/id?1009>

Reaction time and reflex experiments: <http://faculty.washington.edu/chudler/chreflex.html>

Ruler drop activity: <http://faculty.washington.edu/chudler/bex/4rt1.pdf>

Can you hit a fast ball? <http://www.exploratorium.edu/baseball/reactiontime.html>