



# Finding the Balance

## Lesson Plan

### Overview

This lesson uses prairie dog populations as a context for students to explore statistics and determine whether or not a "town" of prairie dogs is increasing in population. Throughout the lesson students will develop a beginning understanding of the three measures of central tendency: the mean (more commonly referred to as the average), median (the middle value when a list of numbers is sorted from smallest to largest), and mode (the number that occurs most often in a list).

Suggested Lesson Sequence	Please see the <a href="#">Earth Systems and Humans</a> module description.
Lesson Level	<u>Extended</u>
Science Connections	<ul style="list-style-type: none"> <li>Students learn about <b>prairie dogs</b> and their <b>population</b> changes.</li> <li>Students consider the <b>impact</b> that <b>animals</b> can have on local <b>vegetation</b>.</li> <li>Students learn that prairie dogs are very important to many other animals on the prairie.</li> </ul>
Math Connections	<ul style="list-style-type: none"> <li>Students determine the <b>mean</b>, <b>median</b> and <b>mode</b> for several <b>sets of numeric data</b>.</li> <li>Students develop a conceptual understanding of the <b>mean</b>, <b>median</b> and <b>mode</b>.</li> <li>Students analyze which measure of <b>central tendency</b> (<b>mean</b>, <b>median</b>, or <b>mode</b>) best describes what is "typical" about a set of data.</li> <li>Students propose and justify <b>conclusions</b> based on <b>data analyses</b>.</li> </ul>
Human Connections	<ul style="list-style-type: none"> <li>Students are exposed to the complex <b>dilemma</b> between <b>people</b> and <b>prairie dogs</b>.</li> </ul>
Lesson Assessment	<ul style="list-style-type: none"> <li><a href="#">Assessment and Standards Table</a> (Word)</li> <li><a href="#">Assessment Activity Description</a></li> <li><a href="#">Authentic Assessment</a></li> </ul>

### Materials

Prairie dog activity sheet ([Word](#))

Vocabulary list ([Word](#))

Learning About Prairie Dogs interactive slideshow ([Powerpoint](#))

Blocks (thirty-five per group of students)

Graph paper (optional)

*About the slideshow:* this slideshow is not meant for students to read through on their own. It is intended to be viewed together, to outline and illustrate a discussion of the lesson's themes, led by the teacher. You might have a different student read each slide's text.

## Vocabulary Words

- Average:** The average is most commonly thought of as the "mean" of a set of numbers. However, "average" may be any measure of central tendency including the mean, mode, or median.
- Mean:** One measure of central tendency that is found by adding all numbers in a set of data, then dividing by the total number of data points added together. The mean takes into consideration all data points in a set of numbers.
- Median:** One measure of central tendency. The median of a set of numbers is the number in the middle of the distribution (after the distribution of numbers has been ordered from smallest to largest).
- Mode:** One measure of central tendency. The mode of a set of numbers is the number in the set that occurs most frequently. A set of numbers may not have a mode, or it may have multiple modes.
- Prairie dog:** A burrowing animal found in central and western North America. People have made it so that prairie dogs live in only about 1 out of 50 areas where they once lived.
- Birth rate:** The number of babies born to a certain population over a period of time is called the "birth rate" of the population.
- Litter:** When a prairie dog female gives birth, the entire group of babies is called the "litter."

*Vocabulary Note:* During this lesson, students will read passages of text on the activity sheets. Students may be unfamiliar with some of the vocabulary presented in this lesson. Encourage your students to ask about words they may be unfamiliar with that occur in the readings, so that they may build their reading skills and pursue additional discussion about these words and their meanings.

## I. Assessing Prior Knowledge

Begin a discussion in class about the numbers that might be used to measure something. Ask them to consider: How do you describe what's typical in a set of numbers? For instance, what is the *typical* height of a student in your class? What is the *typical* amount of snowfall (or rainfall) in your local area for the month of January? Encourage students to discuss these

questions, including how they can both measure the numbers (e.g. measuring a student's height with a yardstick) as well as summarize the numbers as a group.

Note to the teacher: These questions, like many others, require certain statistical tools that have been designed to help collect, study, describe, and interpret data. Quite often, however, these mathematical tools are taught only as procedures, and therefore young children are not exposed to the thinking behind the tools, or the nuances of their uses. For example, many children are taught to find the mean by adding up each data point, and then dividing by the total number of points. What reasoning is behind this algorithm? Are there other measures of the "average?" When is one measure better than another? Which measures take into consideration all of the data, rather than only isolated points? These are important questions that even young children should think about as they begin to use statistical tools to understand the world around them.

## II. Contextual Preparation

To introduce the context of this lesson, view the [Learning about Prairie Dogs](#) Powerpoint file as a class. Students will learn about these fascinating animals and will become introduced to why they are important and controversial in the minds of people across the central part of the United States.

## III. Student Activity

Next, distribute the [Prairie Dogs activity sheet](#). You may wish to engage in a brief discussion in order to ensure that the children understand the context. There is much controversy over prairie dog populations in the western United States. Due to their rapid birth rate, prairie dog populations can grow very large, very quickly. These "towns" of prairie dogs can spread disease, and compete with cattle on rangelands by eating grass. As a result of land use change and subsidized eradication programs, prairie dogs now only occupy approximately 2% of their historical range. Therefore, other groups seek to protect prairie dogs, recognizing their central role in the ecology of the western Great Plains (stretching from northern Mexico to southern Canada) for thousands of years. In the activity, students are to help researchers investigate the birth rate of a town of prairie dogs over the last few years. They do so by studying a data set, and determining the mean, median, and mode to the numbers.

### Teaching notes and anticipated responses to questions:

1. It is important that students understand the data contained in the data table. A different number of mothers were observed each year. These differences across the years will become important later as students investigate the statistics at hand.

Answers will vary. Be sure to probe students' responses in a group discussion. It is important to allow them time to wrestle with the notion of what is "typical" *before* introducing the statistical measures. Sharing ideas with one another will help set the

stage for later conceptual understanding of central tendency.

2. Year 1: 2, 3, 3, 3, 7, 8, 9  
Year 2: 2, 2, 2, 2, 3, 4, 6, 7, 8  
Year 3: 0, 2, 2, 2, 3, 5, 5, 5

3. Answers may vary. Students may have difficulty finding the median for year 3 because there is an even number of data points. Students may also be confused about the mode for year 3 because there are two modes. Do not correct them at this point if they struggle with the data for year 3, as they will come back to this example later in the lesson. Instead, inform the children that they have raised interesting points that will be explore later in the lesson.

	Year 1	Year 2	Year 3
Mode	3	2	2 and 5
Median	3	3	2.5

4. There were multiple modes; there was an even number of data points which made it impossible to find a data point that was exactly in the middle.
5. a) 2 and 5  
b) No, for every year, at least one data point occurred repeatedly.
6. a) The "middle" falls between two data points: between 2 and 3.  
b) This will happen every time with an even set of data points.  
c) 2 and 3  
d) 2.5
7. Students may wish to go back to problem #3 and change their answers in the table. Or, teachers may wish to discuss the table in problem #3 as a whole group.
8. Answers will vary. Some students may choose to use either the mode or the median. Others may choose to use a different number that more closely approximates the mean (which they will find next). Be sure to probe for students' reasoning that supports their answers.
9. Answers will vary. Probe students' thinking. You may wish to engage students in a discussion about the downfalls of the mode and median. Both measures do tell us something about what might be "expected" in a data set. However, both measures also fail to include all data in the set. For example, two or three very large litters of babies will not likely impact the median or mode, yet they do seem to be important

considerations when thinking about how quickly the population might grow. Encourage students to question the relative merits and potential drawbacks of both the mode and median.

10. One good way to introduce the mean is to encourage students to participate in this "leveling-off" activity. As you introduce the concept of the mean, you may wish to use language like "... a fair share" or, "... finding the balance" as students are arranging their blocks. Also, watch for different solution strategies used by students. Many of them will, in fact, model the standard algorithm for the mean perfectly. That is, after establishing how many blocks they need for each tower (babies per mother), they will throw all the blocks together into one group (adding all the values together). Then, they redistribute the blocks equally (one at a time) into "n" piles (divide by n). When students can give a conceptual explanation for this process, they will likely be ready to make the transition from the manipulation of blocks to the use of the standard algorithm for finding the mean.

Towers for Year 1: 7

Towers for Year 2: 9

Towers for Year 3: 8

11. Yes! Having no babies in a litter affects the mean just as much as having 10 babies in a litter. Remember the overall question - are populations increasing or decreasing? A mother that has no babies would support a trend of population decrease just like a mother with 10 babies would lead to a population increase.
12. It would artificially inflate (increase) the mean. It would suggest that the litters, on average, contain more babies than they actually do.
13. This question is a "step back" away from the data to challenge students to think about what their data actually represent. The data are birth rate data only, or the inflow of individuals of a population. However, to calculate the status of an entire population of living things, it is also just as critical to calculate the outflow, or death rate, of a population. You might ask students what they think may affect the death rates as well as birth rates of these animals. Numerous factors, such as weather, food availability, disease (sylvatic/bubonic plague), predation pressure (from animals as well as via human hunting and poisoning), and habitat loss (due to urbanization and farming) can influence the birth and death rates of a prairie dog population.

Decision Time: Answers will vary. Look for students to convey their understanding of each of the three measures of central tendency as they indicate whether the birth rate appears to be increasing or decreasing. Students may wonder about the pros and cons of using one measure over another. In fact, some students may use one statistic to suggest the population is decreasing, while others use a different measure to suggest that it is

increasing. (Teachers should foster this conversation.) This is a dilemma faced (and used) by mathematicians and statisticians all the time. Sometimes one measure will support one viewpoint, while another measure will support an opposing viewpoint. This is an example of how people can manipulate data with statistics - depending on which method of analysis one chooses to use, a single data set can be used to support different sides of an issue. Students should leave this activity well aware of this interesting element of statistics.

#### IV. Assessment

Students should understand how the mean, median and mode relate to a set of data and to one another. They should be able to discuss the relative merits and drawbacks of each of these measures of central tendency. You may revisit the specific questions listed above and have students answer these same questions using a slightly modified data set in order to assess student understanding of these concepts.

#### Lesson Extensions for Authentic Assessment

1) Students could be provided with data sets that will result in a mean that is not a whole number. This should result in a conversation about how to divide up the extra block equally among the different groups or block towers. As students appear ready, teachers may introduce the traditional algorithm for computing the mean. However, avoid rushing children to the algorithm at the expense of conceptual understanding.

2) Scientifically, prairie dogs are referred to as a *keystone species*. This name is appropriate because prairie dogs serve as the critical link (i.e. keystone) among many animal species on the Great Plains. Approximately 170 vertebrate animal species depend upon prairie dog activity at some level for their own survival! Learn more about prairie dog ecology by having students explore some of the species that are dependent upon prairie dog activities for their own survival. These species include:

1. black-footed ferret	5. swift fox	9. mountain plover
2. golden eagle	6. ferruginous hawk	10. prairie falcon
3. burrowing owl	7. bison	11. badger
4. Great Plains toad	8. pronghorn antelope	12. elk

Many of these species (1, 2, 5, 6, 10, and 11) are greatly or wholly dependent upon the prairie dog as a source of food. Other species (3, 4, and 9) are dependent upon prairie dog burrows for shelter. Finally, grazers such as (7, 8, and 12) have been found to preferentially graze near prairie dog towns due to the higher nutrient content in prairie dog town forage.

Have students draw a picture of a prairie dog town, including prairie dog burrows, grasses, prairie dogs themselves, and all or some subset of these 12 animals. Then, have students draw arrows to signify the interactions among these species. Discuss these interactions with the students and discuss what might occur if prairie dogs were to abandon the prairie dog town. (*Many of the other species would be forced to move elsewhere to find other prairie dog towns that they could depend upon.*) Also, be sure to engage students in conversation about what might happen to other species if the population of prairie dogs were to drop significantly. For example, black footed ferrets are particularly dependent on prairie dog populations because it

is the only known species that preys entirely on prairie dogs. No prairie dogs, no food!