How Many Stars Can You Draw in One Minute?

Grades 3–4

This activity develops students' ability to describe and summarize the distribution, or shape, of a data set. Students summarize data by indicating what is typical of the data. They also begin to make comparisons among data sets. In this investigation, students collect data on how many stars they can draw in one minute. They examine a line plot of another class's data collection in the same activity. They summarize and describe the features of their line plots and decide on a typical value in the data. Students also compare line plots, examining the shape of the data, and generate hypotheses to explain the differences.

"Describe the shape and important features of a set of data and compare related data sets, with an emphasis on how the data are distributed." (NCTM 2000, p. 176)

Goals

Students will—

- collect and represent data on line plots;
- describe the shape of data;
- summarize the data, indicating what is typical of the data;
- compare two sets of data on line plots.

Prior Knowledge

Students should have previous experiences in making line plots.

Materials and Equipment

- A class clock with a second hand visible to all students
- Sticky notes
- A copy of the blackline master "How Long Is One Minute?" for each student
- A transparency of the blackline master "How Many Stars?—Another Class" and paper copies for each student
- Mathematics journals or notebook paper

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Classroom Environment

Students work in pairs and in groups of four during this activity.

Activity

Engage

Thinking about one minute. Engage students in a conversation about how long one minute is. Depending on their previous experiences with time, students may not have a good sense of the length of one minute. Ask students to brainstorm tasks they could do in one minute. Give your students some experience in thinking about one minute by asking them to find the number of times in one minute they can do the following: snap their fingers, bounce a basketball, write the word *math*, count

by fours or fives, hop on one foot, and so on. Have students predict how many times they will be able to do each task. Students should record their predictions and then their actual results on copies of the blackline master "How Long Is One Minute?"

While conducting these one-minute tasks, take some time to talk to your students about counting strategies. Counting by ones isn't a very efficient strategy for these tasks. Ask students to suggest ways to count more efficiently. If no one suggests it, propose that for writing the word *math*, students could circle groups of ten *math*s, or for counting by fives, they could reason about how many fives they had counted. They could think, for example, "If I stop at 85, 80 has twice as many fives as 40. I know there are 8 fives in 40, so there are 16 fives in 80. Eighty-five has one more group of five, so I counted by fives 17 times."

Bring students together to share their results from the one-minute tasks. Go over the predictions and results that the students wrote on the activity page "How Long Is One Minute?" Select two of the tasks and have students write their individual results on a class results chart that you create (see fig. 2.3). Direct class discussion by posing the following questions: "What do you notice about the class results?" "Were you surprised by any of your results or by any of the class results?" "Can you think of other tasks that you could do many times in one minute?" Students probably know that a minute is sixty seconds, but they may be surprised by the actual magnitude of one minute or how many times they can perform a task in one minute.

Fig. **2.3.**

Class results chart to show tallies for one-minute tasks

How Much Can I Do in One Minute?—Class Results

Snap Fingers	Bounce Ball	Write *Math*	Count by Fives	Hop on One Foot

Later in this activity, students will be using a line plot to record data. They will also be looking at line plots with data from other groups of people. Depending on your students' previous experience in making line plots, you may want to have them make a quick line plot for one of the tasks they have just performed before moving on. For example, have them make a line plot showing the number of times students counted by fives. Ask the students questions: "What values do we need to list on our line plot below the horizontal line?" "What is the range of our data?" "What are the smallest value and the largest value?" Have students come up to the chalkboard or chart where you are making the line plot and put an X above the number of times they were able to count by fives. Next, spend some time having students summarize and describe any data patterns or trends that they see. When you ask students to describe the data, they will probably point to the value that occurred the most. Remind students that this is called the *mode*. Then encourage them to examine the overall features of the distribution of

the data. Ask them questions such as "How are the data spread out on the line plot?" "Are there any data clustered together?" "What do those clusters tell us?" "Are there any gaps?" "Does the shape of the data surprise you?" "Are there any unusual values?" "Why do you think our data have the shape they do?"

Explore

Tell students that a class of twenty students in another school collected data on how many stars each student could draw in one minute and that you have a line plot showing their results. Before showing them the line plot on the blackline master "How Many Stars?—Another Class," ask students to predict what they think the range of the data values on the line plot will be and what they think the shape of the line plot might look like. Ask them to sketch their predicted line plots in their mathematics journals and to explain their reasons for their predictions. Have partners share their work with each other before asking a few students to share their predictions and reasoning with the whole class.

Next, display a transparency of the blackline master "How Many Stars?—Another Class" on the overhead projecter and distribute a paper copy to each student. Have partners or groups work together to examine the line plot and discuss the questions on the activity page. They should complete question 1 together and question 2 independently. Bring the class together to share a few of the observations that students have made, particularly their statements about the data from the class in question 1. Begin the discussion with questions such as these:

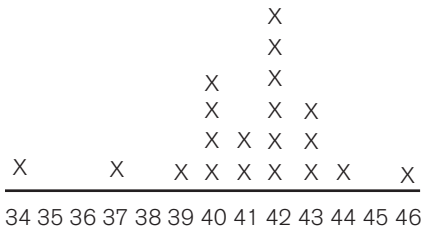
- "What statements did your group record?"
- "What can you tell about this class's star-drawing performance?"
- "What would you say is the typical number of stars a student in this class could draw? Why?"

Students' responses to question 1 may be similar to the following: "There is a fairly wide range." "The smallest number of stars was 34, and the largest was 46 stars." "There is a cluster of data around 40–43." "Most of the students in the class drew between 40 and 43 stars." "Of the 20 students in the class, more than half of them drew between 40 and 43 stars." "A typical student in this class would probably draw about 41 or 42 stars." Next, have students share their predictions about the number of stars that they will draw in one minute (question 2).

Tell students that before they collect data on their class's star drawing, they need to establish some rules. Decide with students what kind of star each student should draw. Tell students that they will do some practice drawing before they begin the data collection. Have students complete question 3 and do some additional practice for homework.

Collecting star data. Distribute some blank paper to each student as well as a sticky note on which to record the results. Lead the star drawing by instructing students to begin when you say "go" and finish when you say "stop." When counting, students should group their stars in clusters of ten (or use another efficient counting method) and record their result on a large line plot using the sticky notes. Have students make their own copy of the line plot in their mathematics journals or on notebook paper. Have students double-check that their recorded line plots accurately correspond to the data collected.

How Many Stars?–Another Class



Next, ask students to summarize and describe the distribution of the data. Again, focus their attention on the shape of the data and the features of the entire data set. Use these questions to guide the discussion: "Are there any clumps or clusters of data?" "What might be some reasons for these clumps or clusters?" "Are there any gaps?" "Are there any unusually large or small data values?" Explain to students that these unusual data are called *outliers.* Outliers are either much higher or much lower than most of the other data values. Can they think of possible explanations for these outliers? What do they think is the typical number of stars drawn by students?

Ask students to work in groups to write a description of the data. They should include their group's decision about how to describe the typical number of stars that a student can draw in one minute. Tell students to be sure to give an explanation for their decision. When you bring all the groups together and ask each one to share its descriptions, encourage the other groups to participate in the discussion by asking questions of their classmates. When students share their thinking about the typical number of stars that can be drawn by students in their class, they may pick a range of numbers, the middle number, or a data value for which there is a high frequency of values.

If students suggest taking the number in the middle of the distribution, explain that mathematicians call the value in the middle of an ordered data set the *median* and that this number is one way to look at what is a typical value in a data set. The median is one type of average or measure of central tendency. It is the midpoint in a data set when the data values are put in numerical order. For example, in the following data set, 45 is the median: 33, 37, 39, 40, 40, 45, 46, 46, 46, 48, 50. When there is an odd number of data values, the median can be found in the data set. When there is an even number of data values, the median is the number in the middle of the two middle numbers. For instance, in the data set 33, 37, 39, 40, 40, 45, there is no one data entry that is exactly in the middle. The median in this instance is the number between the third and the fourth data values, 39 and 40. The median is 39.5. (The activity Do You Get Enough Sleep? develops students' understanding of median.)

Extend

It is important for students to have considerable experience comparing related data sets. By comparing sets of data, students can learn to focus on describing and summarizing the entire data set; they can look for patterns and trends and generate hypotheses to explain them. Have students look back at the line plot that you showed them earlier in this investigation on the blackline master "How Many Stars?—Another Class." Bring students together to share some of their responses after you have asked them to write in their mathematics journals about questions like the following: "What do you notice about the shape of the data of that class's line plot compared with that of the data of our line plot?" "What might be some reasons for what you see?"

Assessment Ideas

When looking at students' work, see if they are making a transition from (*a*) descriptions about data sets that focus on discrete elements of the data, such as "Three students drew 40 stars" or "The largest number of stars drawn was 60," to (*b*) statements that consider the data

as a whole or identify features of the data, such as "There is a large cluster of data between 50 and 60" or "More than half the students drew at least 50 stars." Also look to see if students are able to hypothesize about the shape of the distribution of the data—that is, if they are able to come up with explanations for why the distribution of the data has the shape it does.

Where to Go Next in Instruction?

You can continue making comparisons with related sets of data in many ways. Try investigating the following questions and comparing the data results with your class's original star-drawing data: "How do our data compare with those of an older or younger class?" "How many times can you draw a star with your nonwriting hand?" "Does practice make a difference?" Collect the data from students first without letting them practice and then a second time after allowing them to practice.

For homework, have students ask a parent or another adult to draw as many stars as he or she can in one minute. In class the next day, ask the students to compile their data to answer the question "Do adults draw stars faster than we do?"

After students have developed an understanding of how to describe the shape of a data set and can come up with ways of identifying the typical value in a distribution, they are ready to begin to explore the concept of median more closely. An important element of their learning about methods for analyzing data is learning about the three types of averages: mode, median, and mean. Each of these types of averages is easy to find, but you need to go beyond teaching students the *procedures* for finding them. For these statistics to be truly useful, students need to have a strong conceptual understanding of each and need to know how to interpret each within the context of an entire data set. Having students summarize data sets and identify what they think is typical is an important start. The activities that follow are approaches to developing students' conceptual understanding of median and mean.