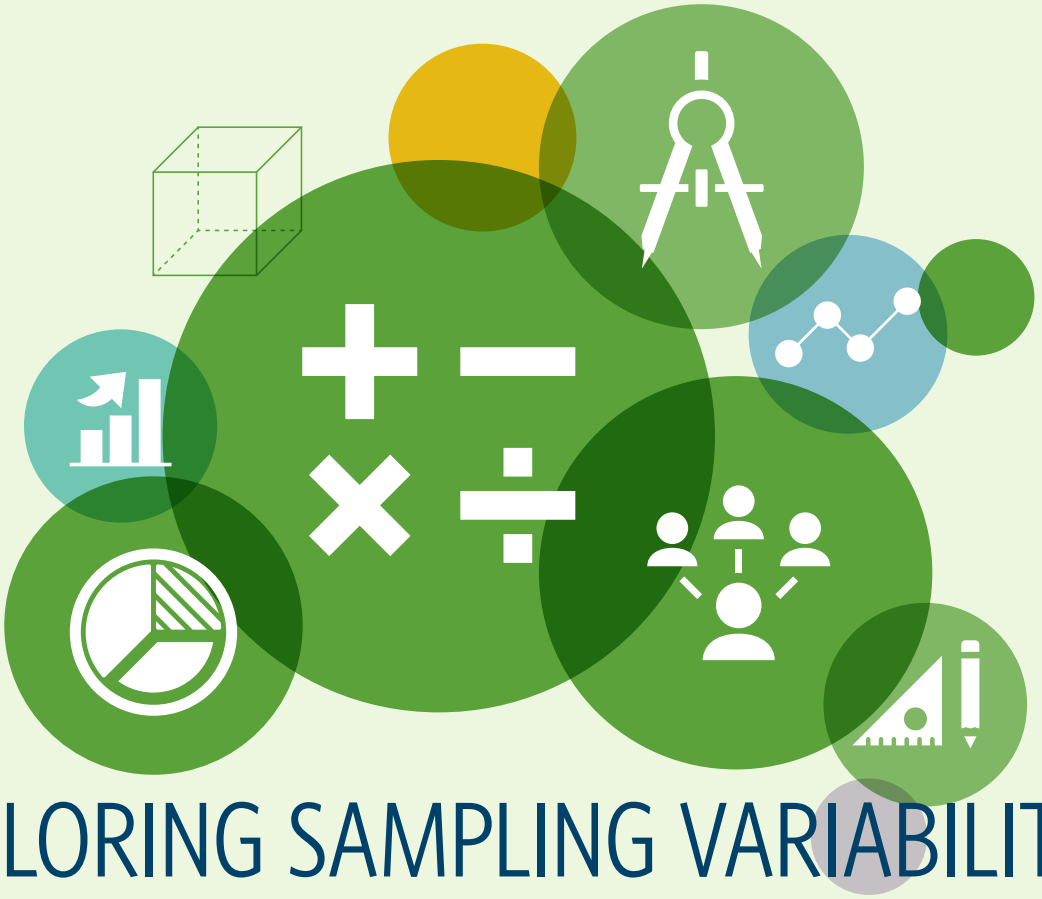


EXPLORING SAMPLING VARIABILITY – HIGHER EDUCATION ATTAINMENT ACROSS THE UNITED STATES

TEACHER VERSION

Subject Level:
Middle School Math

Grade Level:
6-7

Approx. Time Required:
45-60 minutes

Learning Objectives:

- Students will be able to create dot plots of sample percentages.
- Students will be able to use measures of variability to describe different distributions of random samples.
- Students will be able to investigate sampling variability in sample percentages.

United States Census Bureau

Classrooms Powered by Census Data

STATISTICS IN SCHOOLS

Activity Description

Students will explore the sampling variability in sample percentages of states and the District of Columbia where people aged 25 and older had a bachelor's degree in 2014, to determine values over 30 percent.

Suggested Grade Level:
6–7

Approximate Time Required:
45-60 minutes

Learning Objectives:

- Students will be able to create dot plots of sample percentages.
- Students will be able to use measures of variability to describe different distributions of random samples.
- Students will be able to investigate sampling variability in sample percentages.

Topics:

- Dot plots
- Sample percentages
- Sampling variability

Skills Taught:

- Creating a dot plot
- Using measures of center and spread to describe distributions

Materials Required

- The student version of this activity, 18 pages
- A printed version of the data cards in the teacher version of this activity
- Scissors for each student

Activity Item

The following item is part of this activity. The item, its data source, and instructions for viewing the source data online appear at the end of this teacher version.

- Item 1: Data Cards

For more information to help you introduce your students to the U.S. Census Bureau, read "*Census Bureau 101 for Students*." This information sheet can be printed and passed out to your students as well.

Standards Addressed

See charts below. For more information, read "*Overview of Education Standards and Guidelines Addressed in Statistics in Schools Activities*."

Common Core State Standards for Mathematics

Standard	Domain	Cluster
CCSS.MATH.CONTENT.6.SP.B.4 Display numerical data in plots on a number line, including dot plots, histograms, and box plots.	6 SP – Statistics & Probability	Summarize and describe distributions.
CCSS.MATH.CONTENT.6.SP.B.5 Summarize numerical data sets in relation to their context, such as by: **CCSS.MATH.CONTENT.6.SP.B.5.A** Reporting the number of observations. **CCSS.MATH.CONTENT.6.SP.B.5.B** Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.	6 SP – Statistics & Probability	Summarize and describe distributions.

Standard	Domain	Cluster
CCSS.MATH.CONTENT.7.SP.A.1 Understand that statistics can be used to gain information about a population by examining a sample of the population; generalizations about a population from a sample are valid only if the sample is representative of that population. Understand that random sampling tends to produce representative samples and support valid inferences.	7 SP – Statistics & Probability	Use random sampling to draw inferences about a population.
CCSS.MATH.CONTENT.7.SP.A.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. For example, estimate the mean word length in a book by randomly sampling words from the book; predict the winner of a school election based on randomly sampled survey data. Gauge how far off the estimate or prediction might be.	7 SP – Statistics & Probability	Use random sampling to draw inferences about a population.

Common Core State Standards for Mathematical Practice

Standard
CCSS.MATH.PRACTICE.MP4. Model with mathematics. Students will create dot plots to model the variability in sample percentages of the U.S. population across the states and District of Columbia where at least 30 percent of people aged 25 and older had a bachelor's degree in 2014.
CCSS.MATH.PRACTICE.MP6. Attend to precision. Students will distinguish between distributions of sample percentages to understand sampling variability.
CCSS.MATH.PRACTICE.MP7. Look for and make use of structure. Students will examine data distributions to draw conclusions about sampling variability.

National Council of Teachers of Mathematics' Principles and Standards for School Mathematics

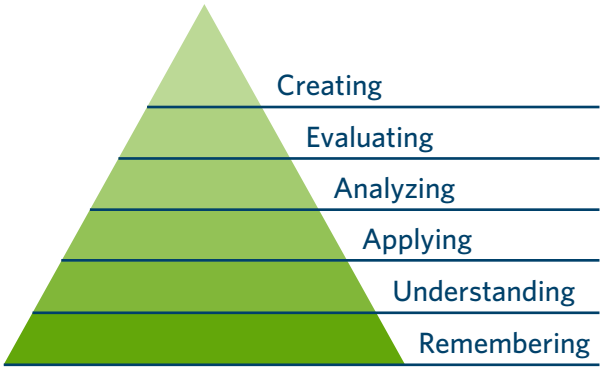
Content Standard	Students should be able to:	Expectation for Grade Band
Data Analysis and Probability	Select and use appropriate statistical methods to analyze data.	Find, use, and interpret measures of center and spread, including mean and interquartile range.
Data Analysis and Probability	Develop and evaluate inferences and predictions that are based on data.	Use observations about differences between two or more samples to make conjectures about the populations from which the samples were taken.

Guidelines for Assessment and Instruction in Statistics Education

GAISE	Level A	Level B	Level C
Formulate Questions	X		
Collect Data		X	
Analyze Data		X	
Interpret Results			X

Bloom's Taxonomy

Students will ***apply*** their knowledge of proportions and percentages to ***create*** and ***analyze*** multiple distributions of sample percentages.



Teacher Notes

Before the Activity

Students must understand the following key terms:

- **Bachelor's degree** – an academic degree (usually representing completion of 4 years of study) awarded by a college or university
- **Population** – the number of people living in an area, representing the entire set of data from which samples can be taken
- **Sample** – a selection of observations from a population
- **Center** – the middle of a sorted data set, usually identified as the median or mean
- **Spread** – the amount of variability among the values in a data set
- **Mean** – a measure of center in a set of numerical data, computed by adding the values in a list and then dividing by the number of values in the list
- **Median** – a measure of center in a set of numerical data, identified as the value appearing at the middle of a sorted version of the list (or the mean of the two middle values if the sorted list contains an even number of values)
- **Random sampling** – the process of randomly selecting a representative subset of the population
- **Range** – the numerical difference between a data set's maximum value and minimum value
- **Sample percentage** – a percentage calculated from a sample set of data
- **Sampling variability** – the concept that a data set's values will vary in repeated random sampling

Students must have the following skill:

- Ability to create a dot plot

Teachers should cut out the following 30 data cards, which each feature a random sample of 10 states, with some including the District of Columbia, and the percentages of their populations aged 25 and older who had a bachelor's degree in 2014. Teachers should be aware that these cards pair with part 1 of the activity, while the data cards in **Item 1** pair with parts 2 and 3.

Teachers should also be aware that some states or the District of Columbia may be listed multiple times on the same data card, given the particular method of random sampling used to gather these data.

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	Pennsylvania	29.0
3	Virginia	36.7
4	North Carolina	28.7
5	Maine	29.4
6	Oregon	30.8
7	Georgia	29.1
8	South Carolina	26.3
9	Florida	27.3
10	Montana	29.3

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Louisiana	22.9
2	Oregon	30.8
3	Nevada	23.1
4	Colorado	38.3
5	Kansas	31.5
6	Illinois	32.8
7	Mississippi	21.1
8	Pennsylvania	29.0
9	California	31.7
10	Kansas	31.5

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Hampshire	35.0
2	California	31.7
3	Louisiana	22.9
4	Virginia	36.7
5	Mississippi	21.1
6	Missouri	27.5
7	Ohio	26.6
8	Wyoming	26.6
9	Washington	33.1
10	Arizona	27.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	23.1
2	Washington	33.1
3	Kansas	31.5
4	Nebraska	29.5
5	Vermont	34.9
6	Kansas	31.5
7	Montana	29.3
8	Virginia	36.7
9	Arizona	27.6
10	Alabama	23.5

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Oregon	30.8
3	Vermont	34.9
4	Oklahoma	24.2
5	California	31.7
6	Alabama	23.5
7	Minnesota	34.3
8	District of Columbia	55.0
9	Massachusetts	41.2
10	North Dakota	27.4

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	23.1
2	New Mexico	26.4
3	District of Columbia	55.0
4	South Dakota	27.8
5	Illinois	32.8
6	West Virginia	19.2
7	Montana	29.3
8	California	31.7
9	Oklahoma	24.2
10	Maryland	38.2

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Alabama	23.5
2	Delaware	30.6
3	Vermont	34.9
4	Georgia	29.1
5	Colorado	38.3
6	Washington	33.1
7	West Virginia	19.2
8	Oklahoma	24.2
9	Indiana	24.7
10	Wyoming	26.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nebraska	29.5
2	Kansas	31.5
3	Minnesota	34.3
4	Missouri	27.5
5	Arkansas	21.4
6	Massachusetts	41.2
7	California	31.7
8	Idaho	25
9	Ohio	26.6
10	District of Columbia	55.0

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	25.3
2	Oregon	30.8
3	Alabama	23.5
4	District of Columbia	55.0
5	District of Columbia	55.0
6	Utah	31.1
7	California	31.7
8	Vermont	34.9
9	West Virginia	19.2
10	Colorado	38.3

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Mexico	26.4
2	Florida	27.3
3	Alaska	28.0
4	South Carolina	26.3
5	New York	34.5
6	Indiana	24.7
7	South Dakota	27.8
8	Idaho	25.0
9	Maine	29.4
10	Louisiana	22.9

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	29.0
2	Michigan	27.4
3	Colorado	38.3
4	Arkansas	21.4
5	Kentucky	22.2
6	Delaware	30.6
7	North Carolina	28.7
8	Michigan	27.4
9	Oklahoma	24.2
10	New Jersey	37.4

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	25.3
2	Iowa	27.7
3	New Mexico	26.4
4	Massachusetts	41.2
5	Oregon	30.8
6	Illinois	32.8
7	Wyoming	26.6
8	Tennessee	25.3
9	Kansas	31.5
10	Louisiana	22.9

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Hawaii	31.0
2	Kansas	31.5
3	South Dakota	27.8
4	Illinois	32.8
5	Colorado	38.3
6	New Mexico	26.4
7	Nebraska	29.5
8	South Dakota	27.8
9	Michigan	27.4
10	Colorado	38.3

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	38.3
2	Massachusetts	41.2
3	Maine	29.4
4	West Virginia	19.2
5	Colorado	38.3
6	Wisconsin	28.4
7	Illinois	32.8
8	Alaska	28.0
9	Oklahoma	24.2
10	Kentucky	22.2

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Florida	27.3
2	Tennessee	25.3
3	Rhode Island	30.4
4	Nebraska	29.5
5	West Virginia	19.2
6	South Carolina	26.3
7	Kentucky	22.2
8	North Dakota	27.4
9	Vermont	34.9
10	Washington	33.1

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Washington	33.1
3	Kentucky	22.2
4	Alabama	23.5
5	West Virginia	19.2
6	Colorado	38.3
7	Maine	29.4
8	Tennessee	25.3
9	Massachusetts	41.2
10	Hawaii	31.0

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Idaho	25.0
2	Maryland	38.2
3	Mississippi	21.1
4	Texas	27.8
5	Iowa	27.7
6	Nevada	23.1
7	Missouri	27.5
8	Kentucky	22.2
9	West Virginia	19.2
10	Alabama	23.5

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	55.0
2	Iowa	27.7
3	Delaware	30.6
4	North Dakota	27.4
5	Massachusetts	41.2
6	New Hampshire	35.0
7	New Hampshire	35.0
8	New Jersey	37.4
9	Louisiana	22.9
10	Nevada	23.1

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	Delaware	30.6
3	Michigan	27.4
4	Oklahoma	24.2
5	Rhode Island	30.4
6	New York	34.5
7	Vermont	34.9
8	New York	34.5
9	Missouri	27.5
10	Maryland	38.2

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	California	31.7
2	Massachusetts	41.2
3	Wyoming	26.6
4	Washington	33.1
5	Texas	27.8
6	Rhode Island	30.4
7	Wyoming	26.6
8	New Hampshire	35.0
9	Michigan	27.4
10	Delaware	30.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Dakota	27.4
2	Kentucky	22.2
3	Nebraska	29.5
4	North Dakota	27.4
5	Washington	33.1
6	Kansas	31.5
7	District of Columbia	55.0
8	Nebraska	29.5
9	Mississippi	21.1
10	Idaho	25.0

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	West Virginia	19.2
3	Oregon	30.8
4	Arkansas	21.4
5	Virginia	36.7
6	Massachusetts	41.2
7	Missouri	27.5
8	Montana	29.3
9	South Carolina	26.3
10	Kentucky	22.2

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Maryland	38.2
2	Rhode Island	30.4
3	Vermont	34.9
4	Tennessee	25.3
5	Louisiana	22.9
6	Oklahoma	24.2
7	New Jersey	37.4
8	Rhode Island	30.4
9	Oklahoma	24.2
10	Mississippi	21.1

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	29.0
2	North Dakota	27.4
3	Michigan	27.4
4	Alabama	23.5
5	Oregon	30.8
6	Ohio	26.6
7	New Hampshire	35.0
8	Indiana	24.7
9	Arkansas	21.4
10	Arizona	27.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	24.7
2	North Dakota	27.4
3	District of Columbia	55.0
4	West Virginia	19.2
5	Indiana	24.7
6	Colorado	38.3
7	District of Columbia	55.0
8	Kentucky	22.2
9	Tennessee	25.3
10	New York	34.5

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	24.7
2	Montana	29.3
3	Tennessee	25.3
4	Montana	29.3
5	Alaska	28.0
6	Illinois	32.8
7	Pennsylvania	29.0
8	Iowa	27.7
9	New York	34.5
10	Wyoming	26.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	38.3
2	District of Columbia	55.0
3	Idaho	25.0
4	South Carolina	26.3
5	Alabama	23.5
6	Kentucky	22.2
7	Maine	29.4
8	Idaho	25.0
9	Pennsylvania	29.0
10	South Carolina	26.3

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Ohio	26.6
2	Montana	29.3
3	Hawaii	31.0
4	Rhode Island	30.4
5	Oregon	30.8
6	North Dakota	27.4
7	Massachusetts	41.2
8	Rhode Island	30.4
9	Illinois	32.8
10	Iowa	27.7

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Virginia	36.7
2	Iowa	27.7
3	Idaho	25.0
4	Nevada	23.1
5	West Virginia	19.2
6	Georgia	29.1
7	South Dakota	27.8
8	Virginia	36.7
9	Montana	29.3
10	New Jersey	37.4

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	55.0
2	Ohio	26.6
3	District of Columbia	55.0
4	Tennessee	25.3
5	Kansas	31.5
6	Virginia	36.7
7	Connecticut	38.0
8	Mississippi	21.1
9	Idaho	25.0
10	Washington	33.1

Source: 2014 American Community Survey 1-Year Estimates
https://data.census.gov/cedsci/table?q=percent%20bachelors%20degree&g=0100000US.04000.001&hidePreview=true&tid=ACSST1Y2014.S1501

During the Activity

Teachers should give each student one of the data cards cut out before the activity, ensuring that all 30 data cards are distributed, so that students can complete the first question. (If there are fewer than 30 students in the class, teachers should give more advanced students two or more data cards; if there are more than 30 students in the class, teachers should put students in groups, giving each group one data card to work on together.)

Teachers should have students share their answers for question 1 of part 1 with the class, as they fill in their tally charts for question 2. If desired, teachers could record the answers in a similar tally chart on the board as well.

After students complete the rest of part 1 individually, teachers should divide them into groups of three for parts 2 and 3. Teachers should instruct students to complete part 4 individually.

After the Activity

Teachers should facilitate a class discussion about how sampling could be used to survey the school's population.

Extension Idea

Teachers could have students conduct the survey described in part 4.

Student Activity

Click ***here*** to download a printable version for students.

Activity Item

The following item is part of this activity and appears at the end of this student version.

- Item 1: Data Cards

Student Learning Objectives

- I will be able to create dot plots of sample percentages.
- I will be able to use measures of variability to describe different distributions of random samples.
- I will be able to investigate sampling variability in sample percentages.

Statisticians often take samples of data from a population instead of surveying the whole population, which saves time and resources. As long as the sample accurately represents the population, data from them can actually tell statisticians a lot. In this activity, you will explore random samples taken from the same population to understand the impact of sampling variability.

Part 1 – Record Data and Make a Dot Plot

1. Review the data card your teacher gave you, which has a sample size of 10. What percentage of your states (and the District of Columbia, if it is included on your card) has a population with at least 30 percent holding a bachelor's degree?

   Example:

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Kansas	31.5
3	Louisiana	22.9
4	Wyoming	26.6
5	Tennessee	25.3
6	Pennsylvania	29.0
7	Michigan	27.4
8	Colorado	38.3
9	Arkansas	21.4
10	Kentucky	22.2

In the sample at left, there are three states with values over 30 percent.

$$\frac{3}{10} \times 100 = 30\%$$

So the sample percentage is 30 percent.

Student answers will vary based on the data card received.

The sample percentage for my data card is _____.

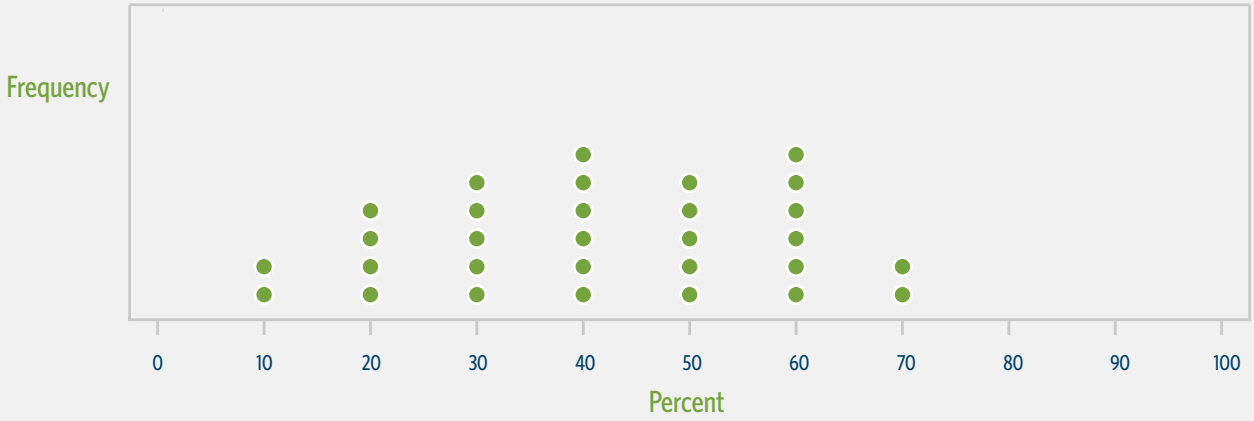
2. As your classmates share their answers to question 1, record them (and yours) in the following tally chart. You should end up with a total of 30 tally marks.

Sample Percentage	Tally Marks
0%	
10%	II
20%	IIII
30%	~~IIII~~
40%	~~IIII~~ I
50%	~~IIII~~
60%	~~IIII~~ I
70%	II
80%	
90%	
100%	

3. Use your chart to create a dot plot of the sample percentages on the grid below. Add a title that includes the sample size and label the horizontal axis. Note that each dot represents a sample of 10 states (and sometimes the District of Columbia), not just one of them.

Student dot plots should look similar to:

Sample Percentages of States and the District of Columbia Where at Least 30 Percent of the Population Has a Bachelor's Degree
(sample size = 10)



4. What is the approximate center of the distribution, and what does this measure show in the context of these data?

   Student answers will vary but could include that the center of the data set is near 40 percent, which represents the average percentage of all states and the District of Columbia in which at least 30 percent of people 25 and older have a bachelor's degree.

5. What is the range of the sample percentages?

   The data points go from 10 to 70 percent, so the range is 60 percent.

6. What do you predict would happen to this center if you analyzed more random samples of this size? Explain.

   The center of the distribution would change slightly, because the percentages in the sample would be different.

Part 2 – Make a Dot Plot With a Larger Sample Size

Now you will work with a group to determine whether the center and spread of a distribution of sample percentages changes if you increase the sample size to 20 (for a total of 15 samples).

Before you get started, cut out all of the data cards from **Item 1: Data Cards**. Now pair the data cards together (data cards 1 and 2, data cards 3 and 4, and so on) until you have paired them all.

1. For each sample of two data cards, calculate the percentage of data points that are at least 30 percent, and record your answers in the chart that follows.

   Example for one sample:

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Oregon	30.8
3	Vermont	34.9
4	Oklahoma	24.2
5	California	31.7
6	Rhode Island	30.4
7	Wyoming	26.6
8	New Hampshire	35.0
9	Michigan	27.4
10	Delaware	30.6

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	25.3
2	Kansas	31.5
3	New Mexico	26.4
4	Massachusetts	41.2
5	Oregon	30.8
6	Minnesota	34.3
7	District of Columbia	55.0
8	Massachusetts	41.2
9	Kansas	31.5
10	Louisiana	22.9

In the sample at left, there are 14 values of at least 30 percent.

$$\frac{14}{20} \times 100 = 70\%$$

Sample #	Percentage where at least 30% of the population has a bachelor's degree
Sample 1 (data cards 1 and 2)	40
Sample 2 (data cards 3 and 4)	45
Sample 3 (data cards 5 and 6)	55
Sample 4 (data cards 7 and 8)	45
Sample 5 (data cards 9 and 10)	40
Sample 6 (data cards 11 and 12)	35
Sample 7 (data cards 13 and 14)	45
Sample 8 (data cards 15 and 16)	40

Sample #	Percentage where at least 30% of the population has a bachelor's degree
Sample 9 (data cards 17 and 18)	35
Sample 10 (data cards 19 and 20)	60
Sample 11 (data cards 21 and 22)	30
Sample 12 (data cards 23 and 24)	35
Sample 13 (data cards 25 and 26)	30
Sample 14 (data cards 27 and 28)	40
Sample 15 (data cards 29 and 30)	45

2. Tally up the percentages for all 15 samples above using the chart below.

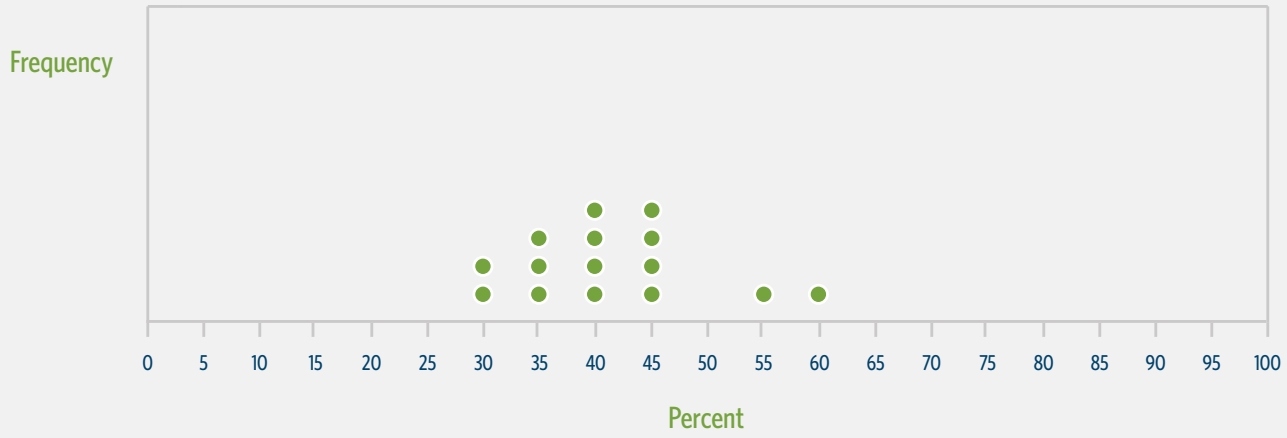
Sample Percentage	Tally Marks
0%	
5%	
10%	
15%	
20%	
25%	
30%	II
35%	III
40%	IIII
45%	IIII
50%	
55%	I

Sample Percentage	Tally Marks
60%	I
65%	
70%	
75%	
80%	
85%	
90%	
95%	
100%	

3. Use your tally chart to create a dot plot on the grid below. Add a title that includes the sample size and label the horizontal axis. Each dot now represents a sample of 20 states (and sometimes the District of Columbia).

   Student dot plots should look similar to:

Sample Percentages of States and the District of Columbia Where at Least 30 Percent of the Population Has a Bachelor's Degree
(sample size = 20)



4. What is the approximate center of the distribution?

   Student answers will vary but could include that the mean of the data set is near 40 percent.

5. What is the range of the sample percentages?

   They go from 30 to 60 percent, so the range is 30 percent.

Part 3 – Make a Dot Plot With a Smaller Sample Size and Compare Measures of Variability

Now you will determine whether the center and spread of the distribution changes if you decrease the sample size to 5 (for a total of 60 samples).

To begin, cut each of your data cards in half horizontally, after row 5, so you have two sets of 30 cards with five percentages on each.

1. For each of your new samples, calculate the percentage of data points that are at least 30 percent, and record your answers in the chart that follows.

   Example for one sample:

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Kansas	31.5
3	Louisiana	22.9
4	Wyoming	26.6
5	Tennessee	25.3

In the sample at left, there are two values of at least 30 percent.

$$\frac{2}{5} \times 100 = 40\%$$

Student answers in the chart below will vary only in terms of order (not value).

Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
1	20
2	60
3	60
4	20
5	60
6	20
7	60
8	80
9	40
10	40
11	60
12	40
13	60
14	40
15	60
16	20
17	60
18	80
19	20
20	20
21	40
22	0
23	40
24	40
25	80

Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
26	60
27	20
28	20
29	20
30	40
31	40
32	20
33	60
34	60
35	0
36	60
37	40
38	60
39	20
40	80
41	60
42	40
43	40
44	60
45	20
46	20
47	40
48	20
49	20
50	0

Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
51	**40**
52	**60**
53	**40**
54	**0**
55	**60**

Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
56	**20**
57	**60**
58	**60**
59	**40**
60	**60**

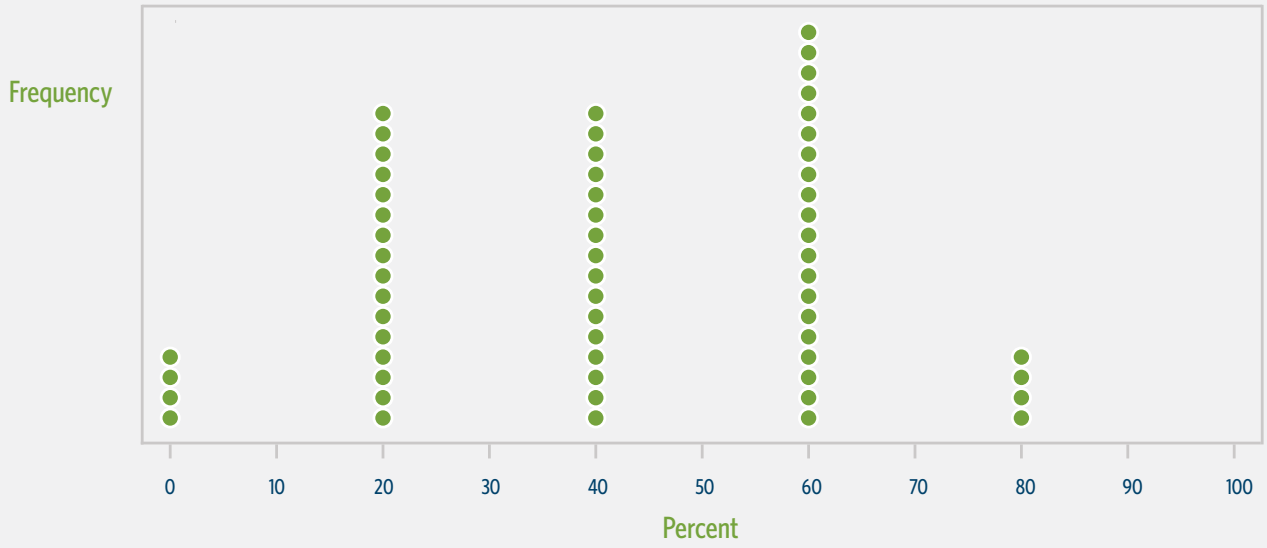
2. Record your group's findings for all 60 samples from the chart above in the tally chart below.

Sample Percentage	Tally Marks
0%	IIII
10%	
20%	~~IIII~~ ~~IIII~~ ~~IIII~~ I
30%	
40%	~~IIII~~ ~~IIII~~ ~~IIII~~ I
50%	
60%	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~
70%	
80%	IIII
90%	
100%	

3. Use the data from your tally chart to make a dot plot of the sample percentages. Add a title that includes the sample size and label the horizontal axis. Each dot now represents a collection of five states (and the District of Columbia, if it applies).

Student dot plots should look similar to:

Sample Percentages of States and the District of Columbia Where at Least 30 Percent of the Population Has a Bachelor's Degree
(sample size = 5)



4. What is the approximate center of the distribution?

   Student answers will vary, but could include that the center of the data set is near 40 percent.

5. What is the range of the sample percentages?

   They go from 0 to 80 percent, so the range is 80 percent.

6. Looking back at the centers and ranges you found for parts 1 and 2, compare these measures of variability for all three sample sizes using the following table.

Sample size	Number of samples	Approximate Center	Range
5	60	**40%**	**80%**
10	30	**40%**	**60%**
20	15	**40%**	**30%**

7. The actual percentage of U.S. states and the District of Columbia in which more than 30 percent of their residents aged 25 and older have bachelor's degrees was 39.2 in 2014. Which sample size (5, 10, or 20) would you use to most accurately estimate this percentage? Explain.

   A sample size of 20, because it has the smallest range of the three sample sizes, meaning the values are closer together. Also, using a larger sample size can make it easier to see the overall pattern of the data.

Part 4 – Apply What You Learned About Sampling

Imagine you want to find out the percentage of students at your school who plan to participate in different types of extracurricular activities next year. Instead of asking each student separately, you can use a sampling method to make predictions.

1. How would you select a random sample of students?

   Student answers will vary but could include getting a list of names of all students from the school administration and then drawing printed slips of their names from a hat.

2. What question(s) would you ask each student in the sample?

   Student answers will vary but could include: Do you plan to participate in an extracurricular activity next year? If so, which one — playing a musical instrument, participating in a sport, joining a club? Are you interested in multiple activities?

3. How would you record the data from your sample?

   Student answers will vary but could include using an electronic spreadsheet.

4. How would you communicate your results to others?

   Student answers will vary but could include publishing an article in the school paper.

5. What would be the advantage of sampling the student body instead of surveying every student individually?

   Sampling would be more efficient and faster.

Item 1: Data Cards

1	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	Pennsylvania	29.0
3	Virginia	36.7
4	North Carolina	28.7
5	Maine	29.4
6	Oregon	30.8
7	Georgia	29.1
8	South Carolina	26.3
9	Florida	27.3
10	Montana	29.3

2	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Louisiana	22.9
2	Oregon	30.8
3	Nevada	23.1
4	Colorado	38.3
5	Kansas	31.5
6	Illinois	32.8
7	Mississippi	21.1
8	Pennsylvania	29.0
9	California	31.7
10	Kansas	31.5

3	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Hampshire	35.0
2	California	31.7
3	Louisiana	22.9
4	Virginia	36.7
5	Mississippi	21.1
6	Missouri	27.5
7	Ohio	26.6
8	Wyoming	26.6
9	Washington	33.1
10	Arizona	27.6

4	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	23.1
2	Washington	33.1
3	Kansas	31.5
4	Nebraska	29.5
5	Vermont	34.9
6	Kansas	31.5
7	Montana	29.3
8	Virginia	36.7
9	Arizona	27.6
10	Alabama	23.5

5	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Oregon	30.8
3	Vermont	34.9
4	Oklahoma	24.2
5	California	31.7
6	Alabama	23.5
7	Minnesota	34.3
8	District of Columbia	55.0
9	Massachusetts	41.2
10	North Dakota	27.4

6	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	23.1
2	New Mexico	26.4
3	District of Columbia	55.0
4	South Dakota	27.8
5	Illinois	32.8
6	West Virginia	19.2
7	Montana	29.3
8	California	31.7
9	Oklahoma	24.2
10	Maryland	38.2

Item 1: Data Cards (Continued)

7	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Alabama	23.5
2	Delaware	30.6
3	Vermont	34.9
4	Georgia	29.1
5	Colorado	38.3
6	Washington	33.1
7	West Virginia	19.2
8	Oklahoma	24.2
9	Indiana	24.7
10	Wyoming	26.6

8	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nebraska	29.5
2	Kansas	31.5
3	Minnesota	34.3
4	Missouri	27.5
5	Arkansas	21.4
6	Massachusetts	41.2
7	California	31.7
8	Idaho	25
9	Ohio	26.6
10	District of Columbia	55.0

9	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	25.3
2	Oregon	30.8
3	Alabama	23.5
4	District of Columbia	55.0
5	District of Columbia	55.0
6	Utah	31.1
7	California	31.7
8	Vermont	34.9
9	West Virginia	19.2
10	Colorado	38.3

10	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Mexico	26.4
2	Florida	27.3
3	Alaska	28.0
4	South Carolina	26.3
5	New York	34.5
6	Indiana	24.7
7	South Dakota	27.8
8	Idaho	25.0
9	Maine	29.4
10	Louisiana	22.9

11	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	29.0
2	Michigan	27.4
3	Colorado	38.3
4	Arkansas	21.4
5	Kentucky	22.2
6	Delaware	30.6
7	North Carolina	28.7
8	Michigan	27.4
9	Oklahoma	24.2
10	New Jersey	37.4

12	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	25.3
2	Iowa	27.7
3	New Mexico	26.4
4	Massachusetts	41.2
5	Oregon	30.8
6	Illinois	32.8
7	Wyoming	26.6
8	Tennessee	25.3
9	Kansas	31.5
10	Louisiana	22.9

Item 1: Data Cards (Continued)

13	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Hawaii	31.0
2	Kansas	31.5
3	South Dakota	27.8
4	Illinois	32.8
5	Colorado	38.3
6	New Mexico	26.4
7	Nebraska	29.5
8	South Dakota	27.8
9	Michigan	27.4
10	Colorado	38.3

14	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	38.3
2	Massachusetts	41.2
3	Maine	29.4
4	West Virginia	19.2
5	Colorado	38.3
6	Wisconsin	28.4
7	Illinois	32.8
8	Alaska	28.0
9	Oklahoma	24.2
10	Kentucky	22.2

15	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Florida	27.3
2	Tennessee	25.3
3	Rhode Island	30.4
4	Nebraska	29.5
5	West Virginia	19.2
6	South Carolina	26.3
7	Kentucky	22.2
8	North Dakota	27.4
9	Vermont	34.9
10	Washington	33.1

16	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	32.8
2	Washington	33.1
3	Kentucky	22.2
4	Alabama	23.5
5	West Virginia	19.2
6	Colorado	38.3
7	Maine	29.4
8	Tennessee	25.3
9	Massachusetts	41.2
10	Hawaii	31.0

17	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Idaho	25.0
2	Maryland	38.2
3	Mississippi	21.1
4	Texas	27.8
5	Iowa	27.7
6	Nevada	23.1
7	Missouri	27.5
8	Kentucky	22.2
9	West Virginia	19.2
10	Alabama	23.5

18	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	55.0
2	Iowa	27.7
3	Delaware	30.6
4	North Dakota	27.4
5	Massachusetts	41.2
6	New Hampshire	35.0
7	New Hampshire	35.0
8	New Jersey	37.4
9	Louisiana	22.9
10	Nevada	23.1

Item 1: Data Cards (Continued)

19	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	Delaware	30.6
3	Michigan	27.4
4	Oklahoma	24.2
5	Rhode Island	30.4
6	New York	34.5
7	Vermont	34.9
8	New York	34.5
9	Missouri	27.5
10	Maryland	38.2

20	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	California	31.7
2	Massachusetts	41.2
3	Wyoming	26.6
4	Washington	33.1
5	Texas	27.8
6	Rhode Island	30.4
7	Wyoming	26.6
8	New Hampshire	35.0
9	Michigan	27.4
10	Delaware	30.6

21	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Dakota	27.4
2	Kentucky	22.2
3	Nebraska	29.5
4	North Dakota	27.4
5	Washington	33.1
6	Kansas	31.5
7	District of Columbia	55.0
8	Nebraska	29.5
9	Mississippi	21.1
10	Idaho	25.0

22	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	28.7
2	West Virginia	19.2
3	Oregon	30.8
4	Arkansas	21.4
5	Virginia	36.7
6	Massachusetts	41.2
7	Missouri	27.5
8	Montana	29.3
9	South Carolina	26.3
10	Kentucky	22.2

23	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Maryland	38.2
2	Rhode Island	30.4
3	Vermont	34.9
4	Tennessee	25.3
5	Louisiana	22.9
6	Oklahoma	24.2
7	New Jersey	37.4
8	Rhode Island	30.4
9	Oklahoma	24.2
10	Mississippi	21.1

24	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	29.0
2	North Dakota	27.4
3	Michigan	27.4
4	Alabama	23.5
5	Oregon	30.8
6	Ohio	26.6
7	New Hampshire	35.0
8	Indiana	24.7
9	Arkansas	21.4
10	Arizona	27.6

Item 1: Data Cards (Continued)

25	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	24.7
2	North Dakota	27.4
3	District of Columbia	55.0
4	West Virginia	19.2
5	Indiana	24.7
6	Colorado	38.3
7	District of Columbia	55.0
8	Kentucky	22.2
9	Tennessee	25.3
10	New York	34.5

26	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	24.7
2	Montana	29.3
3	Tennessee	25.3
4	Montana	29.3
5	Alaska	28.0
6	Illinois	32.8
7	Pennsylvania	29.0
8	Iowa	27.7
9	New York	34.5
10	Wyoming	26.6

27	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	38.3
2	District of Columbia	55.0
3	Idaho	25.0
4	South Carolina	26.3
5	Alabama	23.5
6	Kentucky	22.2
7	Maine	29.4
8	Idaho	25.0
9	Pennsylvania	29.0
10	South Carolina	26.3

28	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Ohio	26.6
2	Montana	29.3
3	Hawaii	31.0
4	Rhode Island	30.4
5	Oregon	30.8
6	North Dakota	27.4
7	Massachusetts	41.2
8	Rhode Island	30.4
9	Illinois	32.8
10	Iowa	27.7

29	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Virginia	36.7
2	Iowa	27.7
3	Idaho	25.0
4	Nevada	23.1
5	West Virginia	19.2
6	Georgia	29.1
7	South Dakota	27.8
8	Virginia	36.7
9	Montana	29.3
10	New Jersey	37.4

30	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	55.0
2	Ohio	26.6
3	District of Columbia	55.0
4	Tennessee	25.3
5	Kansas	31.5
6	Virginia	36.7
7	Connecticut	38.0
8	Mississippi	21.1
9	Idaho	25.0
10	Washington	33.1

Source: 2014 American Community Survey 1-Year Estimates
https://data.census.gov/cedsci/table?q=percent%20bachelors%20degree&g=0100000US.04000.001&hidePreview=true&tid=ACSST1Y2014.S1501