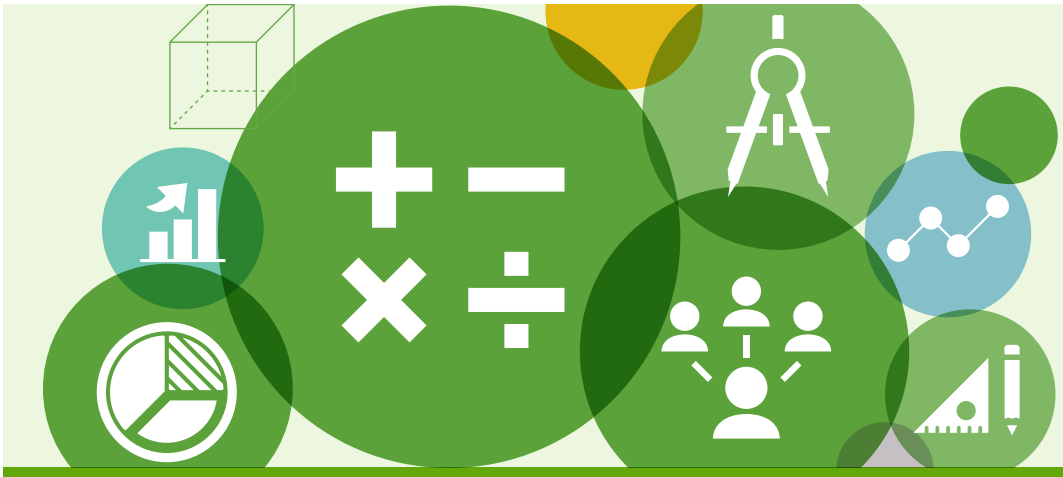


STUDENT VERSION

EXPLORING SAMPLING VARIABILITY – HIGHER EDUCATION ATTAINMENT ACROSS THE UNITED STATES

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.

NAME:_____ DATE:_____

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	35.8
2	Kansas	34.0
3	Louisiana	25.0
4	Wyoming	29.1
5	Tennessee	28.7
6	Pennsylvania	32.3
7	Michigan	30.0
8	Colorado	42.7
9	Arkansas	23.3
10	Kentucky	25.1

In the sample at left, there are 5 states with values of at least 30 percent.

$$\frac{5}{10} \times 100 = 50\%$$

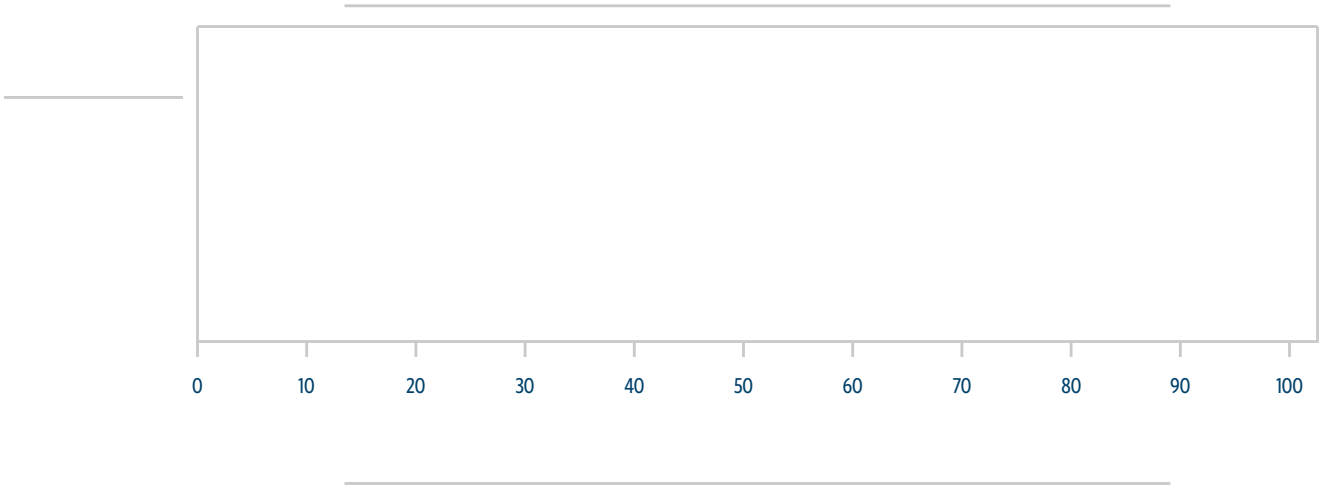
So the sample percentage is 50 percent.

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%	
20%	
30%	
40%	
50%	
60%	
70%	
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.



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

5. What is the range of the sample percentages?

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

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	35.8
2	Oregon	34.5
3	Vermont	38.7
4	Oklahoma	26.2
5	California	35.0
6	Rhode Island	34.8
7	Wyoming	29.1
8	New Hampshire	37.6
9	Michigan	30.0
10	Delaware	33.2

	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	28.7
2	Kansas	34.0
3	New Mexico	27.7
4	Massachusetts	45.0
5	Oregon	34.5
6	Minnesota	37.3
7	District of Columbia	59.7
8	Massachusetts	45.0
9	Kansas	34.0
10	Louisiana	25.0

In the sample at left, there are 15 values of at least 30 percent.

$$\frac{15}{20} \times 100 = 75\%$$

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

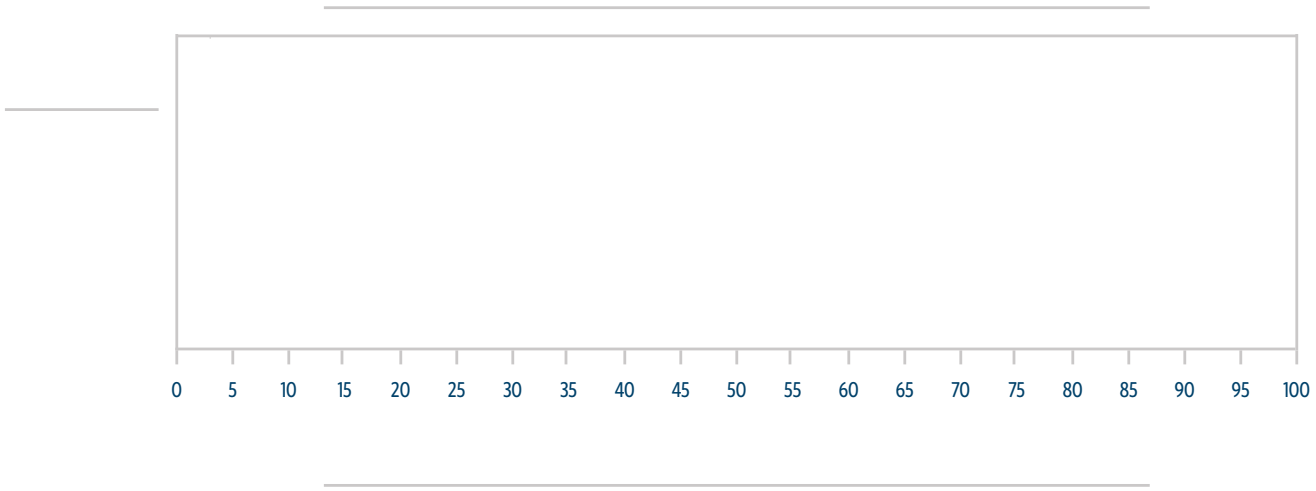
Sample #	Percentage where at least 30% of the population has a bachelor's degree
9 (data cards 17 and 18)	
10 (data cards 19 and 20)	
11 (data cards 21 and 22)	
12 (data cards 23 and 24)	
13 (data cards 25 and 26)	
14 (data cards 27 and 28)	
15 (data cards 29 and 30)	

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%	
35%	
40%	
45%	
50%	
55%	

Sample Percentage	Tally Marks
60%	
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).



4. What is the approximate center of the distribution?

5. What is the range of the sample percentages?

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	35.8
2	Kansas	34.0
3	Louisiana	25.0
4	Wyoming	29.1
5	Tennessee	28.7

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

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

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

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

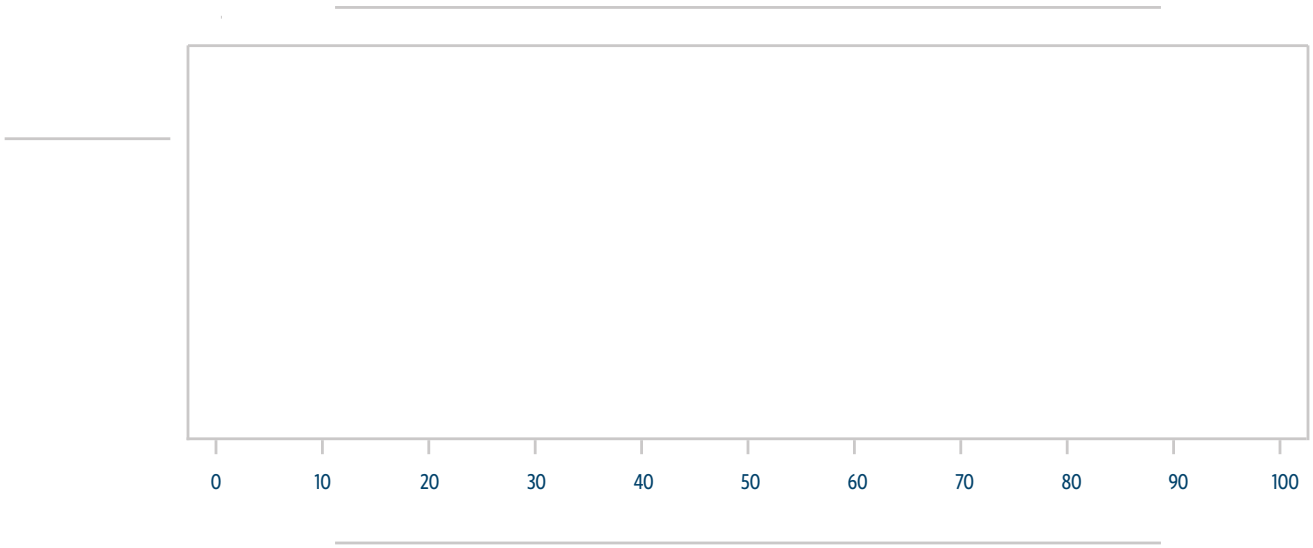
Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
51	
52	
53	
54	
55	

Sample #	Percentage of the states and District of Columbia where at least 30% of the population has a bachelor's degree
56	
57	
58	
59	
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%	
10%	
20%	
30%	
40%	
50%	
60%	
70%	
80%	
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).



4. What is the approximate center of the distribution?

5. What is the range of the sample percentages?

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		
10	30		
20	15		

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 66.7 in 2019. Which sample size (5, 10, or 20) would you use to most accurately estimate this percentage? Explain.

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?

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

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

4. How would you communicate your results to others?

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

Item 1: Data Cards

1	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	32.3
2	Pennsylvania	32.3
3	Virginia	39.6
4	North Carolina	32.3
5	Maine	33.2
6	Oregon	34.5
7	Georgia	32.5
8	South Carolina	29.6
9	Florida	30.7
10	Montana	33.6

2	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Louisiana	25.0
2	Oregon	34.5
3	Nevada	25.7
4	Colorado	42.7
5	Kansas	34.0
6	Illinois	35.8
7	Mississippi	22.3
8	Pennsylvania	32.3
9	California	35.0
10	Kansas	34.0

3	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Hampshire	37.6
2	California	35.0
3	Louisiana	25.0
4	Virginia	39.6
5	Mississippi	22.3
6	Missouri	30.2
7	Ohio	29.3
8	Wyoming	29.1
9	Washington	37.0
10	Arizona	30.2

4	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	25.7
2	Washington	37.0
3	Kansas	34.0
4	Nebraska	33.2
5	Vermont	38.7
6	Kansas	34.0
7	Montana	33.6
8	Virginia	39.6
9	Arizona	30.2
10	Alabama	26.3

5	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	35.8
2	Oregon	34.5
3	Vermont	38.7
4	Oklahoma	26.2
5	California	35.0
6	Alabama	26.3
7	Minnesota	37.3
8	District of Columbia	59.7
9	Massachusetts	45.0
10	North Dakota	30.4

6	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nevada	25.7
2	New Mexico	27.7
3	District of Columbia	59.7
4	South Dakota	29.7
5	Illinois	35.8
6	West Virginia	21.1
7	Montana	33.5
8	California	35.0
9	Oklahoma	26.2
10	Maryland	40.9

Item 1: Data Cards (Continued)

7	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Alabama	26.3
2	Delaware	33.2
3	Vermont	38.7
4	Georgia	32.5
5	Colorado	42.7
6	Washington	37.0
7	West Virginia	21.1
8	Oklahoma	26.2
9	Indiana	26.9
10	Wyoming	29.1

8	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Nebraska	33.2
2	Kansas	34.0
3	Minnesota	37.3
4	Missouri	30.2
5	Arkansas	23.3
6	Massachusetts	45.0
7	California	35.0
8	Idaho	28.7
9	Ohio	29.3
10	District of Columbia	59.7

9	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	28.7
2	Oregon	34.5
3	Alabama	26.3
4	District of Columbia	59.7
5	District of Columbia	59.7
6	Utah	34.8
7	California	35.0
8	Vermont	38.7
9	West Virginia	21.1
10	Colorado	42.7

10	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	New Mexico	27.7
2	Florida	30.7
3	Alaska	30.2
4	South Carolina	29.6
5	New York	37.8
6	Indiana	26.9
7	South Dakota	29.7
8	Idaho	28.7
9	Maine	33.2
10	Louisiana	25.0

11	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	32.3
2	Michigan	30.0
3	Colorado	42.7
4	Arkansas	23.3
5	Kentucky	25.1
6	Delaware	33.2
7	North Carolina	32.3
8	Michigan	30.0
9	Oklahoma	26.2
10	New Jersey	41.2

12	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Tennessee	28.7
2	Iowa	29.3
3	New Mexico	27.7
4	Massachusetts	45.0
5	Oregon	34.5
6	Illinois	35.8
7	Wyoming	29.1
8	Tennessee	28.7
9	Kansas	34.0
10	Louisiana	25.0

Item 1: Data Cards (Continued)

13	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Hawaii	33.6
2	Kansas	34.0
3	South Dakota	29.7
4	Illinois	35.8
5	Colorado	42.7
6	New Mexico	27.7
7	Nebraska	33.2
8	South Dakota	29.7
9	Michigan	30.0
10	Colorado	42.7

14	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	42.7
2	Massachusetts	45.0
3	Maine	33.2
4	West Virginia	21.1
5	Colorado	42.7
6	Wisconsin	31.3
7	Illinois	35.8
8	Alaska	30.2
9	Oklahoma	26.2
10	Kentucky	25.1

15	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Florida	30.7
2	Tennessee	28.7
3	Rhode Island	34.8
4	Nebraska	33.2
5	West Virginia	21.1
6	South Carolina	29.6
7	Kentucky	25.1
8	North Dakota	30.4
9	Vermont	38.7
10	Washington	37.0

16	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Illinois	35.8
2	Washington	37.0
3	Kentucky	25.1
4	Alabama	26.3
5	West Virginia	21.1
6	Colorado	42.7
7	Maine	33.2
8	Tennessee	28.7
9	Massachusetts	45.0
10	Hawaii	33.6

17	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Idaho	28.7
2	Maryland	40.9
3	Mississippi	22.3
4	Texas	30.8
5	Iowa	29.3
6	Nevada	25.7
7	Missouri	30.2
8	Kentucky	25.1
9	West Virginia	21.1
10	Alabama	26.3

18	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	59.7
2	Iowa	29.3
3	Delaware	33.2
4	North Dakota	30.4
5	Massachusetts	45.0
6	New Hampshire	37.6
7	New Hampshire	37.6
8	New Jersey	41.2
9	Louisiana	25.0
10	Nevada	25.7

Item 1: Data Cards (Continued)

19	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	32.3
2	Delaware	33.2
3	Michigan	30.0
4	Oklahoma	26.2
5	Rhode Island	34.8
6	New York	37.8
7	Vermont	38.7
8	New York	37.8
9	Missouri	30.2
10	Maryland	40.9

20	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	California	35.0
2	Massachusetts	45.0
3	Wyoming	29.1
4	Washington	37.0
5	Texas	30.8
6	Rhode Island	34.8
7	Wyoming	29.1
8	New Hampshire	37.6
9	Michigan	30.0
10	Delaware	33.2

21	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Dakota	30.4
2	Kentucky	25.1
3	Nebraska	33.2
4	North Dakota	30.4
5	Washington	37.0
6	Kansas	34.0
7	District of Columbia	59.7
8	Nebraska	33.2
9	Mississippi	22.3
10	Idaho	28.7

22	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	North Carolina	32.3
2	West Virginia	21.1
3	Oregon	34.5
4	Arkansas	23.3
5	Virginia	39.6
6	Massachusetts	45.0
7	Missouri	30.2
8	Montana	33.6
9	South Carolina	29.6
10	Kentucky	25.1

23	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Maryland	40.9
2	Rhode Island	34.8
3	Vermont	38.7
4	Tennessee	28.7
5	Louisiana	25.0
6	Oklahoma	26.2
7	New Jersey	41.2
8	Rhode Island	34.8
9	Oklahoma	26.2
10	Mississippi	22.3

24	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Pennsylvania	32.3
2	North Dakota	30.4
3	Michigan	30.0
4	Alabama	26.3
5	Oregon	34.5
6	Ohio	29.3
7	New Hampshire	37.6
8	Indiana	26.9
9	Arkansas	23.3
10	Arizona	30.2

Item 1: Data Cards (Continued)

25	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	26.9
2	North Dakota	30.4
3	District of Columbia	59.7
4	West Virginia	21.1
5	Indiana	26.9
6	Colorado	42.7
7	District of Columbia	59.7
8	Kentucky	25.1
9	Tennessee	28.7
10	New York	37.8

26	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Indiana	26.9
2	Montana	33.6
3	Tennessee	28.7
4	Montana	33.6
5	Alaska	30.2
6	Illinois	35.8
7	Pennsylvania	32.3
8	Iowa	29.3
9	New York	37.8
10	Wyoming	29.1

27	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Colorado	42.7
2	District of Columbia	59.7
3	Idaho	28.7
4	South Carolina	29.7
5	Alabama	26.3
6	Kentucky	25.1
7	Maine	33.2
8	Idaho	28.7
9	Pennsylvania	32.3
10	South Carolina	29.6

28	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Ohio	29.3
2	Montana	33.6
3	Hawaii	33.6
4	Rhode Island	34.8
5	Oregon	34.5
6	North Dakota	30.4
7	Massachusetts	45.0
8	Rhode Island	34.8
9	Illinois	35.8
10	Iowa	29.3

29	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	Virginia	39.6
2	Iowa	29.3
3	Idaho	28.7
4	Nevada	25.7
5	West Virginia	21.1
6	Georgia	32.5
7	South Dakota	29.7
8	Virginia	39.6
9	Montana	33.6
10	New Jersey	41.2

30	State/District	Percentage of People 25 and Older With Bachelor's Degree
1	District of Columbia	59.7
2	Ohio	29.3
3	District of Columbia	59.7
4	Tennessee	28.7
5	Kansas	34.0
6	Virginia	39.6
7	Connecticut	39.8
8	Mississippi	22.3
9	Idaho	28.7
10	Washington	37.0

Source: 2019 American Community Survey, 1-Year Estimates