Unit 6, Lesson 10

Using Data Displays to Find Associations

Goals

- Create a two-way table and a segmented bar graph that represent relative frequencies, and interpret (orally) the frequencies in context.
- Determine (in writing) whether categorical data has a positive, negative, or no association using a relative frequency table or segmented bar graph, and justify (orally) the reasoning.

Learning Targets

- I can create relative frequency tables, bar graphs, and segmented bar graphs from frequency tables to find associations among variables.

Lesson Narrative

In this lesson, students use two-way tables, bar graphs, and segmented bar graphs to decide whether or not there is evidence of an association in categorical data (MP4). At this level, students are looking for relative frequencies that appear very different between categories.

Standards

Addressing **8.SP.A.4**

Instructional Routines

- MLR1: Stronger and Clearer Each Time

Required Materials

Materials to Gather

- Colored pencils: Activity 3
- Straightedges: Activity 3

Required Preparation

Lesson:

Use the data from the previous lesson's *Cool-down* to build a two-way table of students' responses. Provide access to materials for students to create their own segmented bar graphs including colored pencils and straightedges.

Student Facing Learning Goals

Let's use data displays to find associations.

10.1 Sports and Musical Instruments

Warm-up

5 min

Activity Narrative

The purpose of this *Warm-up* is for students to answer questions about relative frequency of items after finding missing information in a two-way table.

Monitor for students who find the percentages for the final two questions using different strategies to share during the whole-class discussion.

Standards

Addressing **8.SP.A.4**

Launch

Give students 2 minutes of quiet work time followed by a whole-class discussion.

Student Task Statement

For a survey, students in a class answered these questions:

- Do you play a sport?
- Do you play a musical instrument?

1. Here is a two-way table that gives some results from the survey. Complete the table, assuming that all students answered both questions.

	plays instrument	does not play instrument	total
plays sport	5		16
does not play sport			
total		15	25

2. To the nearest percentage point, what percentage of students who play a sport *don't* play a musical instrument?
3. To the nearest percentage point, what percentage of students who *don't* play a sport also *don't* play a musical instrument?

Student Response

1.

	plays instrument	does not play instrument	total
plays sport	5	11, since $16 - 5 = 11$.	16
does not play sport	5, since $9 - 4 = 5$.	4, since $15 - 11 = 4$.	9, since $25 - 16 = 9$.
total	10, since $25 - 15 = 10$.	15	25

2. 69%, since $\frac{11}{16} = 0.6875$.
3. 44%, since $\frac{4}{9} = 0.444\ldots$.

Activity Synthesis

Ask students to share the missing information they found for the table. Record and display their responses for all to see.

Select previously identified students to explain how they found the percentages for the final 2 questions and what that percentage represents. Select students who:

1. Find a percentage using the values given (for example, 31%, since $\frac{5}{16} \approx 0.31$), then subtract from 100% (for example, 69%, since $100 - 31 = 69$) to answer the question.
2. Find the actual values first by subtracting (for example, $16 - 5 = 11$) then computing the percentage (for example, 69%, since $\frac{11}{16} = 0.6875$).

Ask the rest of the class if they agree or disagree with the strategies and give time for any questions they have.

10.2 Sports and Music Association

15 min

Activity Narrative

Now that students are more familiar with two-way tables showing relative frequency, they are ready to create their own segmented bar graphs. In this activity, students create two segmented bar graphs based on the same two-way table by considering percentages of the rows and columns separately. After creating the segmented bar graphs, they are analyzed to determine if there is an association present in the data.

Standards

Addressing **8.SP.A.4**

Instructional Routines

- MLR1: Stronger and Clearer Each Time

Launch

Arrange students in groups of 2. After a brief introduction, give 5–10 minutes of quiet work time. Ask students to compare their answers with their partner and try to resolve any differences. Finish with a whole-class discussion.

Display the two-way table from the data collected about the class's playing sports and musical instruments. If the data is

unavailable, the data from this lesson's *Warm-up* can be used.

Tell students they should work with their partners to each work on one of the graphs. One student should work on problems 1 and 2 while their partner should work on 3 and 4. After they have completed their graphs, they should work together to understand their partner's graphs and complete the last problem together.

Access for Students with Disabilities

Action and Expression: Internalize Executive Functions. Invite students to plan a strategy, including the tools they will use, for creating a segmented bar graph. If time allows, invite students to share their plan with a partner before they begin.
Supports accessibility for: Attention, Social-Emotional Functioning

Student Task Statement

Your teacher will give you a two-way table with information about the number of people in your class who play sports or musical instruments.

1. Complete this table to make a two-way table for the data from earlier. The table will show relative frequencies *by row*.

	plays instruments	does not play instruments	row total
plays sports			100%
does not play sports			100%

2. Make a segmented bar graph for the table. Use one bar of the graph for each row of the table.

3. Complete the table to make a two-way table for the data from earlier. The table will show relative frequencies *by column*.

	plays instruments	does not play instruments
plays sports		
does not play sports		
column total	100%	100%

4. Using the values in the table, make a segmented bar graph. Use one bar of the graph for each column of the table.

5. Based on the two-way tables and segmented bar graphs, do you think there is an association between playing a sport and playing a musical instrument? Explain how you know.

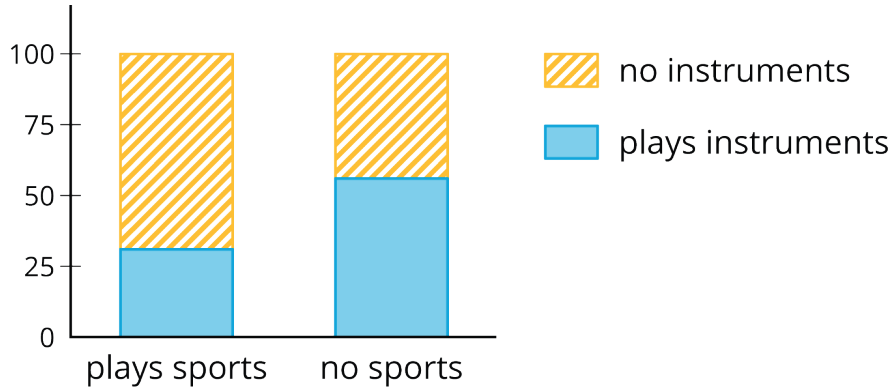
Student Response

Answers vary based on class data. For the *Warm-up* data:

1.

	plays instruments	does not play instruments	row total
plays sports	31%, since $5 \div 16 = 0.3125$	69%, since $11 \div 16 = 0.6875$	100%
does not play sports	56%, since $5 \div 9 = 0.\overline{5}$	44%, since $4 \div 9 = 0.\overline{4}$	100%

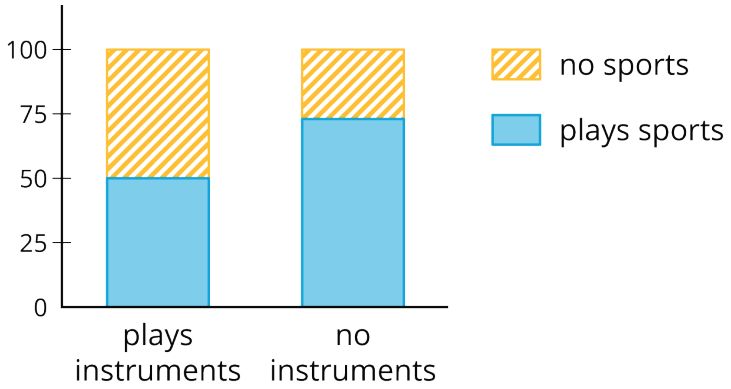
2.



3.

	plays instrument	does not play instrument
plays sport	50%, since $5 \div 10 = 0.5$.	73%, since $11 \div 15 = 0.7\overline{3}$.
does not play sport	50%, since $5 \div 10 = 0.5$.	27%, since $4 \div 15 = 0.2\overline{6}$.
column total	100%	100%

4.



5. I think there is a negative association between playing a sport and playing an instrument. Students who play sports are less likely than their other classmates to play instruments, and students who play instruments are less likely than their other classmates to play sports.

Building on Student Thinking

Students may draw the segmented bar graph incorrectly. Most likely, they will accidentally graph frequency instead of relative frequency. They may also graph relative frequencies, but without stacking them. Both segmented bars should go from 0 to 100.

Activity Synthesis

To clarify how to create and interpret segmented bar graphs, ask:

- "Why are the numbers in the top left box in the two tables different? What do they mean?" (In the first table, the number represents the percentage who also play musical instruments out of all the people who play sports. In the second table, the number represents the percentage of people who also play sports out of all the people who play musical instruments.)
- "Suppose you are in the band room with students who play instruments. To estimate what percentage of these students play sports, would you use the first or second segmented bar graph? Explain your reasoning." (The second one, because I already know they play an instrument, so I would be looking for the percentages within that category.)
- "Is there an association between the two variables? Explain or show your reasoning." (The answer will depend on class data, but the reasoning should include an analysis of the relative frequencies within categories. There is an association if the percentages within one category are very different from the percentages in another category.)

If there is an association, ask what the segmented bar graphs would look like if there was no association. If there is not an association, ask what the segmented bar graphs would look like if there was one. (If there is an association, the bars will look different because the percentages in each category will be very different. If there is not an association, the

segmented bar graph should have bars that are very similar because the percentages will be close to one another.)

Access for English Language Learners

MLR1 Stronger and Clearer Each Time. Before the whole-class discussion, give students time to meet with 2–3 partners to share and get feedback on their first draft response to the last question. Invite listeners to ask questions and give feedback that will help their partner clarify and strengthen their ideas and writing. Give students 3–5 minutes to revise their first draft based on the feedback they receive.
Advances: Writing, Speaking, Listening

10.3 Colored Erasers

15 min

Activity Narrative

This activity provides students less structure for their work in creating segmented bar graphs to determine an association (MP4). In addition, the data in this activity is split into more than two options. Students work individually to create a segmented bar graph based on either columns or rows and then share their information with a partner who has created the other segmented bar graph. Together, partners discuss the segmented bar graphs to determine if there is an association between the variables (MP3). In particular, students should notice that there is evidence of an association if the relative frequencies within a category are very different from the relative frequencies in another category.

As students work, identify groups that use the different segmented bar graphs to explain why there is an association between the color of the eraser and flaws.

Standards

Addressing **8.SP.A.4**

Launch

Keep students in groups of 2. Give 5 minutes quiet work time followed by 5 minutes of partner discussion and then a whole-class discussion.

Provide students access to colored pencils. Either assign or have partners choose which will make a graph for each row and which will make a graph for each column.

Access for Students with Disabilities

Representation: Access for Perception. Ask students to read the directions aloud to their partner. Students who both listen to and read the information will benefit from extra processing time.
Supports accessibility for: Language, Attention

Student Task Statement

An eraser factory has five machines. One machine makes the eraser shapes. Then each shape goes through the red machine, blue machine, yellow machine, or green machine to have a side colored.

The manager notices that an uncolored side of some erasers is flawed at the end of the process and wants to know which machine needs to be fixed: the shape machine or some of the color machines. The manager collected data on the number of flawed and unflawed erasers of each color.

1. Work with a partner. Each of you should make 1 segmented bar graph for the data in the table.

   One segmented bar graph should have a bar for each *row* of the table.

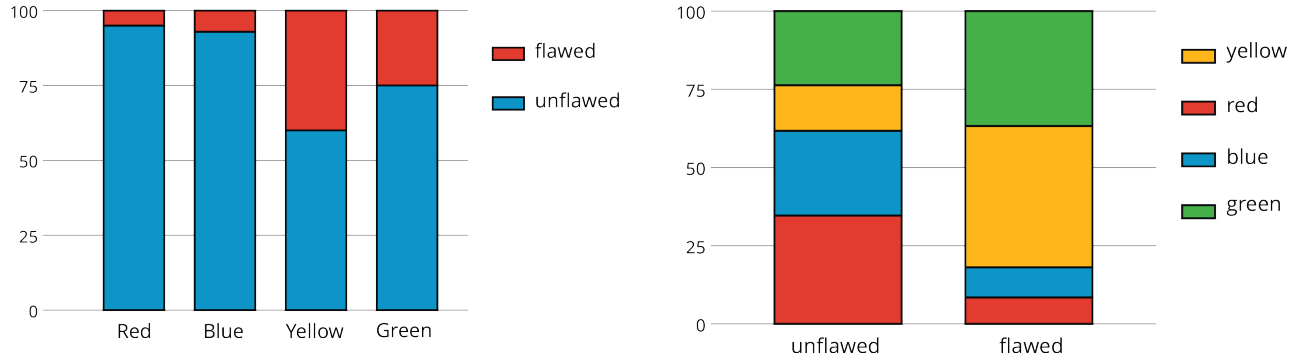
   The other segmented bar graph should have one bar for each *column* of the table.

	unflawed	flawed	total
red	285	15	300
blue	223	17	240
yellow	120	80	200
green	195	65	260
total	823	177	1000

2. Are the flawed erasers associated with certain colors? If so, which colors? Explain your reasoning.

Student Response

1.



2. The flawed erasers are positively associated with the yellow and green erasers. A much higher percentage of the total yellow and green erasers are flawed than red and blue are flawed. The yellow and green erasers also make up a larger percentage of the total flawed erasers.

Are You Ready for More?

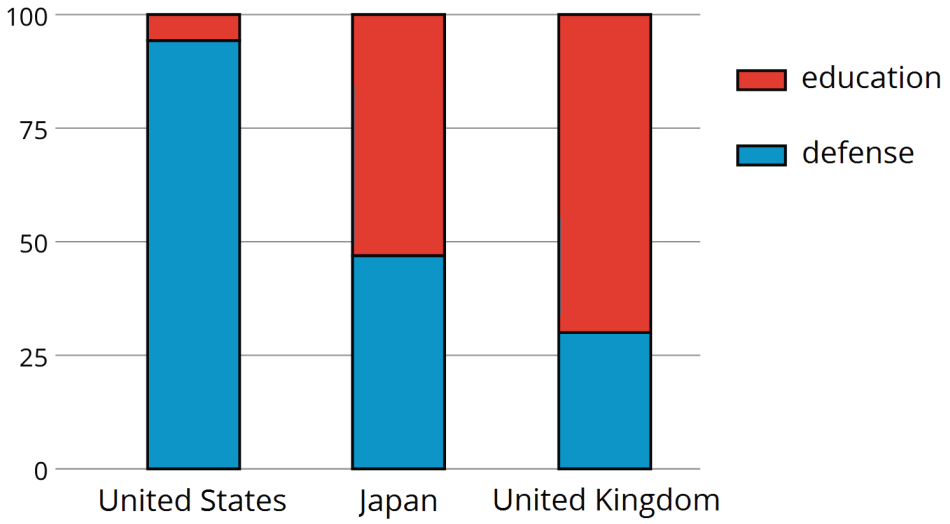
Based on the federal budgets for 2009, the table shows where some of the federal money was expected to go. The values are in billions of U.S. dollars.

	United States	Japan	United Kingdom
defense	718.4	42.8	49.2
education	44.9	47.5	113.9

1. Why would a segmented bar graph be more useful than the table of data to see any associations between the country and where the money is spent?
2. Create a segmented bar graph that represents the data from the table.

3. Is there an association between the country's budget and their spending in these areas? Explain your reasoning.

Extension Student Response

1. Sample response: The total amount of money spent by the United States is so much greater than the other countries that it would help to see the percentages rather than actual dollars spent.
2. 

3. There is an association. The United States spends a much larger percentage of its budget on defense than on education relative to the other countries. Japan spends almost equal amounts on defense and education while the United Kingdom spends a lot more on education than on defense.

Activity Synthesis

The purpose of this discussion is to identify strategies for creating segmented bar graphs and analyzing them to determine if there is an association among variables.

Ask, "What strategies did you use to create the segmented bar graphs?" (First, we created a new table of the relative frequencies. Then we approximated the heights of the segments based on the percentages from the table.)

Select previously identified groups based on whether they used rows or column relative frequencies to share their explanation for noticing an association.

After both explanations are shared, ask students, "Do you think that noticing the association was easier with one of the graphs?" (Likely the segmented bar graph based on rows is easier since there are only 2 segments and it is easier to see that the yellow and green erasers are more flawed.)

Finally, ask students, "If there was not an association between color and flaws, what might the segmented bar graph based on the rows look like? What might the segmented bar graph based on the columns look like?" (The segmented bar graph based on the rows would have each segmented bar look about the same. That is, the line dividing the 2 segments would be at about the same height in each bar. The segmented bar graph based on the columns would have segments that are all approximately equal. That is, each segment should represent about 25% of the entire bar.)

Lesson Synthesis

Remind students that we have been looking for associations in categorical data, and that there is evidence of an association if the relative frequencies of some characteristic are very different from each other in the different groups. Ask:

- "Is it easier to see evidence of an association in a frequency table or a *relative* frequency table?" (It depends on the data. If the two groups are approximately the same size, it doesn't matter very much, but when they are different sizes, it is usually easier to compare using relative frequencies.)
- "How can we see evidence of an association in a two-way table of either kind?" (by numerically comparing the proportions between the 2 groups)
- "How can we see evidence of an association in a bar graph or segmented bar graph?" (by visually comparing the proportions between the 2 groups)

10.4 Class Preferences

Cool-down

5 min

Students are given a two-way table in which one variable has more than two outcomes and segmented bar graph to determine if there is an association between the two variables.

Standards

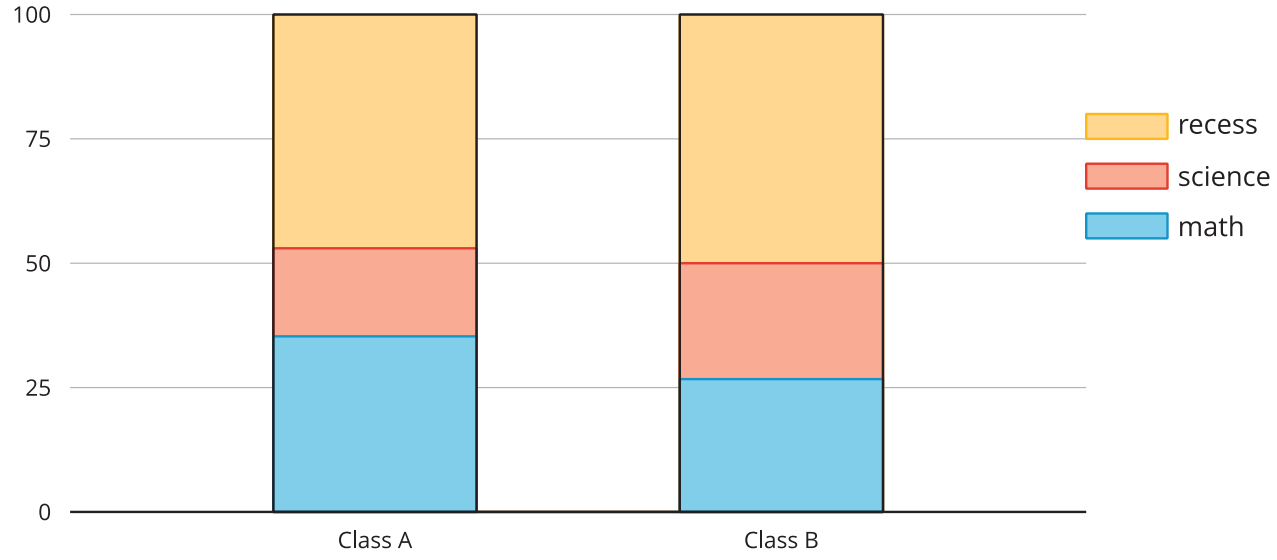
Addressing **8.SP.A.4**

Student Task Statement

Here are a two-way table and segmented bar graph for data from students in 2 classes.

Do they show evidence of differences between the 2 classes?

	prefers math	prefers science	prefers recess
class A	6	3	8
class B	8	7	15



Student Response

There is no evidence of different preferences associated with each class because the segments in the bars are about the same size.

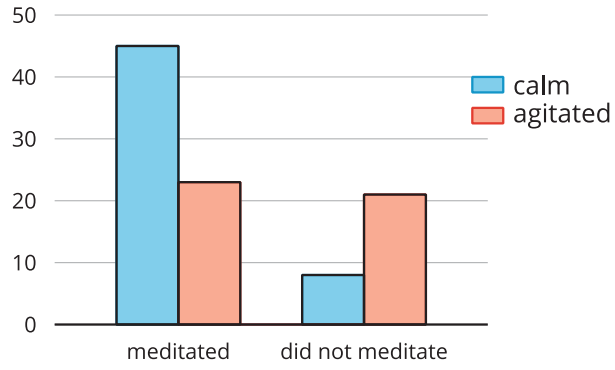
Responding to Student Thinking

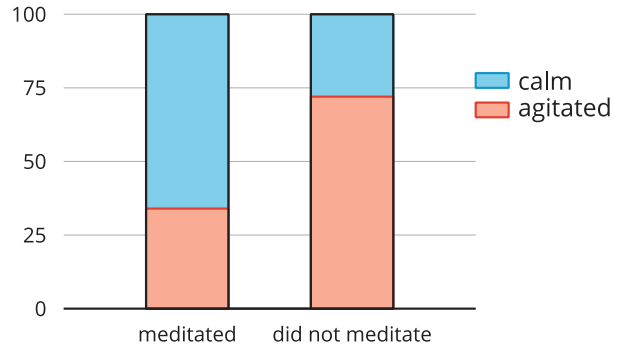
Press Pause
By this point in the unit, there should be some student mastery of working with two-way tables and segmented bar graphs. If most students struggle, make time to examine related work in the section referred to here. The Course Guide provides additional ideas for revisiting earlier work.

Grade 8, Unit 6, Section C Associations in Categorical Data

Lesson 10 Summary

In an earlier lesson, we looked at data on meditation and state of mind in athletes.





Is there an association between meditation and state of mind?

The bar graph shows that more athletes were calm than agitated among the group that meditated, and more athletes were agitated than calm among the group that did not.

We can see the proportions of calm meditators and calm non-meditators from the segmented bar graph, which shows that about 66% of athletes who meditated were calm, whereas only about 27% of those who did not meditate were calm.

This does not necessarily mean that meditation causes calmness. It could be the other way around, where calm athletes are more inclined to meditate. However, it does suggest that there is an association between meditating and calmness.

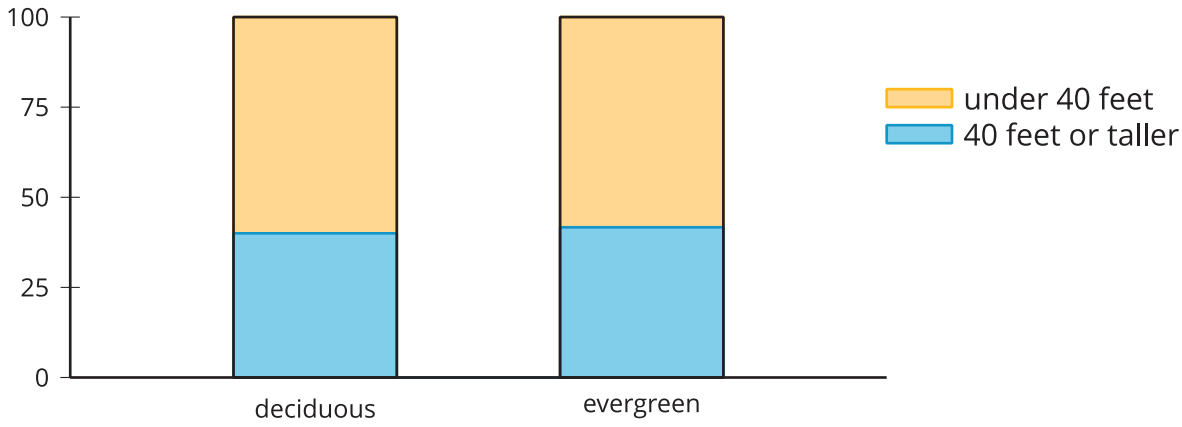
Lesson 10 Practice Problems

1 Student Task Statement

An ecologist is studying a forest with a mixture of tree types. Since the average tree height in the area is 40 feet, he measures the height of the tree against that. He also records the type of tree. The results are shown in the table and segmented bar graph.

Is there evidence of an association between tree height and tree type? Explain your reasoning.

	under 40 feet	40 feet or taller	total
deciduous	45	30	75
evergreen	14	10	24
total	59	40	99



Solution

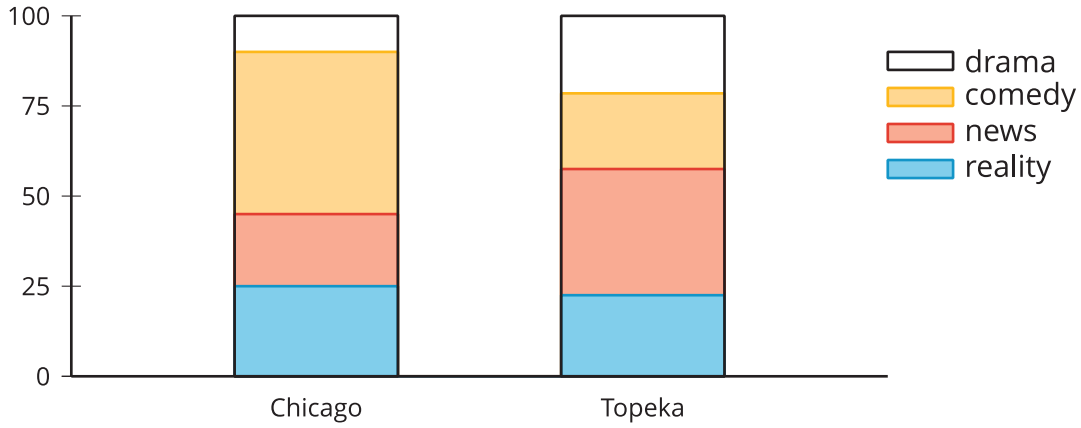
No. Sample reasoning: 60% of the deciduous trees are under 40 feet, and 40% are 40 feet or taller. Similarly, about 58% of evergreens are under 40 feet, and about 42% are 40 feet or taller. From the data recorded, there is not a clear association.

2 Student Task Statement

Workers at an advertising agency are interested in people's TV viewing habits. They take a survey of people in 2 cities to try to find patterns in the types of shows they watch. The results are recorded in a table and shown in a segmented bar graph.

Is there evidence of different viewing habits? If so, explain.

	reality	news	comedy	drama
Chicago	50	40	90	20
Topeka	45	70	40	45



Solution

Yes. Sample reasoning: Topekans watch news and dramas much more than Chicagoans. Chicagoans watch comedies much more. They watch about the same amount of reality TV.

3 Student Task Statement

A scientist is interested in whether certain species of butterflies like certain types of local flowers. The scientist captures butterflies in 2 zones with different flower types and records the number caught.

Do these data show an association between butterfly type and zone?

Explain your reasoning.

	zone 1	zone 2
eastern tiger swallowtail	16	34
monarch	24	46

Solution

No. Sample reasoning: 32% of eastern tiger swallowtails and about 34% of monarchs were found in zone 1, so there is not a large difference in type of butterfly.