Lesson 4: Dot plots

Goals

- Describe (orally and in writing) a distribution represented by a dot plot, including informal observations about its centre and spread.

- Interpret a dot plot to answer (in writing) statistical questions about a data set and to identify (orally) what values are "typical" for the distribution.

Learning Targets

- I can describe the centre and spread of data from a dot plot.

Lesson Narrative

In this lesson, students continue to choose appropriate representation to display qualitative and quantitative data, reason abstractly and quantitatively by interpreting the displays in context, and study and comment on features of data distributions they show. Here they begin to use the everyday meaning of the word "typical" to describe a characteristic of a group. They are also introduced to the idea of using centre and spread to describe distributions generally. Planted here are seeds for the idea that values near the centre of the distribution can be considered "typical" in some sense. These concepts are explored informally at this stage but will be formalised over time, as students gain more experience in describing distributions and more exposure to different kinds of distributions.

Building On

- Recognise a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question because one anticipates variability in students' ages.

Addressing

- Understand that a set of data collected to answer a statistical question has a distribution which can be described by its centre, spread, and overall shape.

- Summarise and describe distributions.

- Display quantitative data in plots on a number line, including dot plots, histograms, and box plots.

- Reporting the number of observations.

Building Towards

- Recognise that a measure of centre for a quantitative data set summarises all of its values with a single number, while a measure of variation describes how its values vary with a single number.

- Giving quantitative measures of centre (median and/or mean) and variability/spread (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

Instructional Routines

- Compare and Connect

- Think Pair Share

Student Learning Goals

Let's investigate what dot plots and bar graphs can tell us.

4.1 Pizza Toppings (Part 1)

Warm Up: 5 minutes

This warm-up serves two purposes. It prompts students to determine when a dot plot is an appropriate representation and allows students to practice organising data into a frequency table. The table completed in this activity will be used in the following activity in this lesson.

Launch

Arrange students in groups of 2. Give students 2 minutes to complete the activity with a partner, and then another 1–2 minutes for them to compare their frequency tables with another group.

Student Task Statement

Fifteen customers in a pizza shop were asked, "How many toppings did you add to your cheese pizza?" Here are their responses:

1 2 1 3 0 1 1 2
0 3 0 0 1 2 2

1. Could you use a dot plot to represent the data? Explain your reasoning.

2. Complete the table.

number of toppings	frequency (number)
0	
1	
2	

3	

Student Response

1. Yes. The data on the number of toppings are numerical, so a dot plot would be suitable to organise them.

number of toppings	frequency (number)
0	4
1	5
2	4
3	2

Activity Synthesis

Ask a couple of students to share their responses to the first question and poll the class for their agreement or disagreement.

4.2 Pizza Toppings (Part 2)

10 minutes

After organising the data set into a frequency table in the warm-up, students now represent the information graphically. The drawing of the plot should be fairly straightforward. The emphasis here is on using a graphical representation to study and comment on the data distribution, and to reinforce how it allows us to make observations that are difficult to make by looking at lists and tables.

As students work, identify those who describe distributions not only in terms of individual categories or values (e.g. "four people did not order any toppings") but also characterise them in broader terms (e.g. "almost all customers in the data set ordered 2 or fewer toppings"). Invite them to share during the discussion following the activity.

Instructional Routines

*   Think Pair Share

Launch

Keep students in groups of 2. Give students 4–5 minutes of quiet work time and 1–2 minutes to share their responses with a partner.

Action and Expression: Develop Expression and Communication. Invite students to talk about their ideas with a partner before writing them down. Display sentence frames to support students when they explain their ideas. For example, "I notice that . . .," or "I know ____ because . . ."
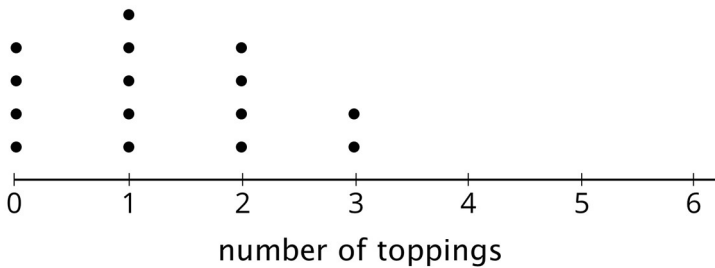*Supports accessibility for: Language; Organisation*

Student Task Statement

1. Use the tables from the warm-up to display the number of toppings as a dot plot. Label your drawing clearly.

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├────┼────┼────┼────┼────┼────┤
0    1    2    3    4    5    6
```
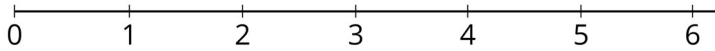
2. Use your dot plot to study the distribution for number of toppings. What do you notice about the number of toppings that this group of customers ordered? Write 2–3 sentences summarising your observations.

Student Response

1.

```
          •
     •    •    •
     •    •    •
     •    •    •    •
     •    •    •    •
├────┼────┼────┼────┼────┼────┤
0    1    2    3    4    5    6
      number of toppings
```

2. Answers vary. Sample response: Most customers ordered 0, 1, or 2 toppings. Nobody ordered 4 or more toppings. The most common number of toppings was 1.

Are You Ready for More?

Think of a statistical question that can be answered with the data about the number of toppings ordered, as displayed on the dot plot. Then answer this question.

Student Response

Answers vary. Sample responses:

- What is the largest number of toppings ordered by the fifteen customers? (3)

- What percentage of the customers in the data set ordered 3 toppings? (About 13%)

Activity Synthesis

Display a completed dot plot for all to see. Solicit as many observations or comments about the distribution as time permits. The goal of this discussion is to allow students to hear as

many ways to describe distributions as possible. Be sure to select previously identified students to make observations that succinctly capture the distributions.

4.3 Homework Time

20 minutes

In the previous activity, students commented on distributions on a dot plot and had opportunities to hear different ways to describe distributions. In this activity, they begin to think about how to characterise a distribution as a whole, in terms of its *centre* and *spread*. Students learn that we can give a general description of a distribution by identifying a location that could be the centre of the data, and by noting how alike or different the data points are.

Note that at this point "centre" and "spread" can only be identified and described informally, via visual observation and intuitive reasoning about how data points are distributed. The lack of precise ways to identify centre and spread helps to cultivate the need for more formal measures later.

In this activity, students evaluate and critique another's reasoning.

Instructional Routines
- Compare and Connect

Launch

Keep students in groups of 2. Ask students to read the question in the stem, "How many hours do you generally spend on homework each week?" Then, ask students to explain why this is a statistical question. This is a statistical question because it can be answered by collecting data, and we can expect variability in the data.

Give them 6–7 minutes of quiet time to work on the first three questions, and then 4–5 minutes to share their responses with their partner and to complete the last two questions together. Be sure to leave at least 5 minutes for a whole-class discussion.

Representation: Internalise Comprehension. Activate or supply background knowledge about calculating percentages. Allow students to use calculators to ensure inclusive participation in the activity.
*Supports accessibility for: Memory; Conceptual processing*

Anticipated Misconceptions

Students may not recall how to find a percentage. Remind them that a percentage can be found if we know the size of a part and that of a whole. If needed, prompt them to determine the size of the entire data set.

Student Task Statement

Twenty-five Year 7 students answered the question: "How many hours do you generally spend on homework each week?"

This dot plot shows the number of hours per week that these 25 students reported spending on homework.

hours spent on homework per week
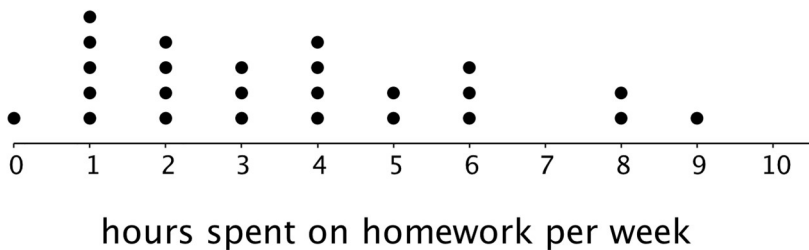
Use the dot plot to answer the following questions. For each, show or explain your reasoning.

1. What percentage of the students reported spending 1 hour on homework each week?

2. What percentage of the students reported spending 4 or less hours on homework each week?

3. Would 6 hours per week be a good description of the number of hours this group of students spends on homework per week? What about 1 hour per week? Explain your reasoning.

4. What value do you think would be a good description of the homework time of the students in this group? Explain your reasoning.

5. Someone said, "In general, these students spend roughly the same number of hours doing homework." Do you agree? Explain your reasoning.

Student Response
1. 20%. 5 of the students reported spending 1 hour on homework each week. 5 out of 25 is 20%.

2. 68%. 17 students reported spending 4 or less hours on homework each week. 17 out of 25 is 68%.

3. Answers vary. Sample response: 6 hours would not be a good value for a typical number of hours. Only 3 students in the group reported spending this much time per week doing homework. Most of the group spent a lot less. One hour would also not be a good estimate. Even though 5 students spent this much time on homework, nearly all other students spent much more.

4. Answers vary. Sample response: I would say that a good estimate would be around 3–4 hours, which is the middle of the set, with about the same number of values above and below.

5. Answers vary. Sample response: I disagree. Most of the data spreads out from 0 to 9 hours. There is a student who does not do homework at all, and there are several spending 8–9 hours per week.

Activity Synthesis

Ask a couple of students to share their thinking on what number of hours would be a good description of homework time for this group of students and why. Then, select a couple of other students to discuss how alike or different the lengths of homework time are.

Explain that sometimes it helps to describe a set of data generally, or to characterise it as a whole. One way to do that is by finding a value that describes the whole set reasonably well, or a value whose location can be considered the "centre" of a distribution. Ask students:

*   "Where on the dot plot would you consider the centre of the data? What is the value of that centre?"

Another way to characterise a data set is by describing its "spread," or the variability in the data points. The wider the spread (the more dispersed the data points are on a dot plot), the more variable or different they are. The narrower the spread (the more clustered together), the more alike they are. Ask students:

*   "Based on the dot plot, how would you describe the spread of the students' homework time? Are the amounts of time they spend on homework alike or different?"

Tell students that we will continue to explore centre and spread in upcoming lessons.

Representing, Writing: Compare and Connect. Ask pairs of students to prepare a display for a summary statement that generalises the number of hours spent on homework each week using the sentence frame, "Based on this data set, spending ___ hours on homework each week is typical for Year 7 students because…". Note a handful of sentences to highlight in the discussion. Give students opportunities to compare their statements with those shared and agree or disagree with each sentence, providing reasons for their agreement or disagreement supported by the data. Give students 1-2 minutes to revise their statements prior to collecting them for display. This will help students to develop conceptual

understanding for "typical."
Design Principle(s): Maximise meta-awareness, Cultivate conversation

Lesson Synthesis

In this lesson, we look closely at data sets and try to describe what is typical for the data set. We notice that if we study the distribution of data, we can find out what is typical or common.

- What does the term "typical" mean? When someone wants to find out "a typical height of year 7 students," what is the information of interest?

- How do tell what is typical from a dot plot such as this one? How might we describe the characteristics of this data set on dog weights?
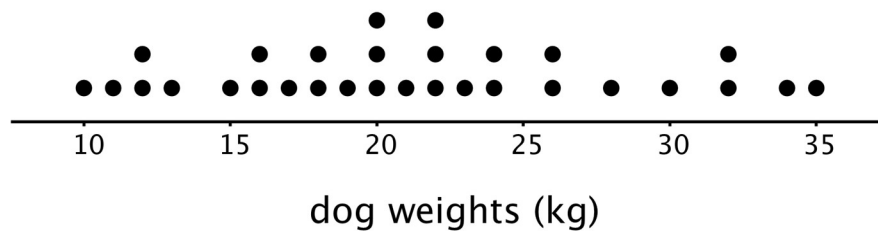
4.4 Family Size

Cool Down:

Student Task Statement

A group of students was asked, "How many children are in your family?" The responses are displayed in the dot plot.
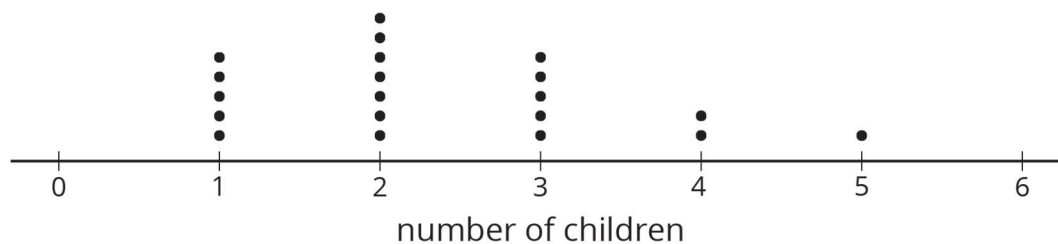
1. How many students responded to the questions?

2. What percentage of the students have more than one child in the family?

3. Write a sentence that describes the distribution of the data shown on the dot plot.

Student Response
1. There are 20 dots and each corresponds to one student in the group.

2. 75%. 15 out of 20 students answered that there are 2 or more children in the family.

3.   Answers vary. Sample response: A typical number of children for this group of families is around 2, but some families had many more children than others. There are no students with more than 5 children in the family.

Student Lesson Summary

We often collect and analyse data because we are interested in learning what is "typical," or what is common and can be expected in a group.

Sometimes it is easy to tell what a typical member of the group is. For example, we can say that a typical shape in this set is a large circle.
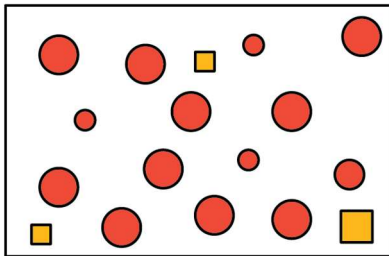
Just looking at the members of a group doesn't always tell us what is typical, however. For example, if we are interested in the side length typical of squares in this set, it isn't easy to do so just by studying the set visually.
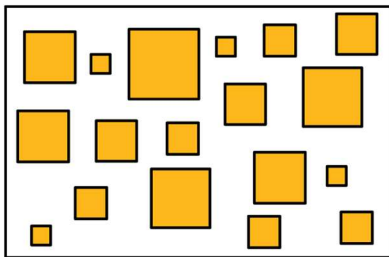
In a situation like this, it is helpful to gather the side lengths of the squares in the set and look at their distribution, as shown in this dot plot.

side lengths in centimetres
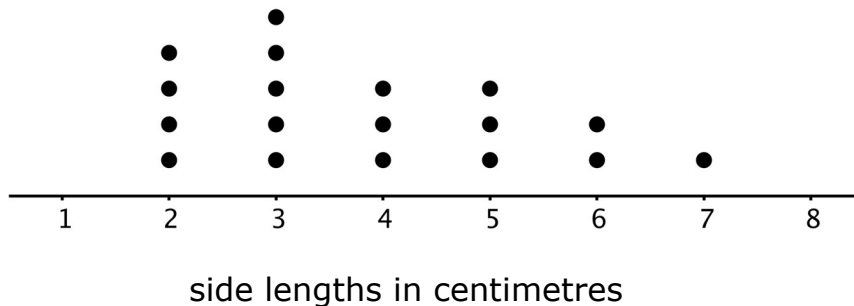
We can see that many of the data points are between 2 and 4, so we could say that side lengths between 2 and 4 centimetres or close to these lengths are typical of squares in this set.

Lesson 4 Practice Problems

Problem 1 Statement

Clare recorded the amounts of time spent doing homework, in hours per week, by students in year 7, year 9, and year 11. She made a dot plot of the data for each year group and provided the following summary.

– Students in year 7 tend to spend less time on homework than students in year 9 and year 11.

– The homework times for the year 11 students are more alike than the homework times for the year 9 students.

Use Clare's summary to match each dot plot to the correct year group (year 7, year 9, or year 11).
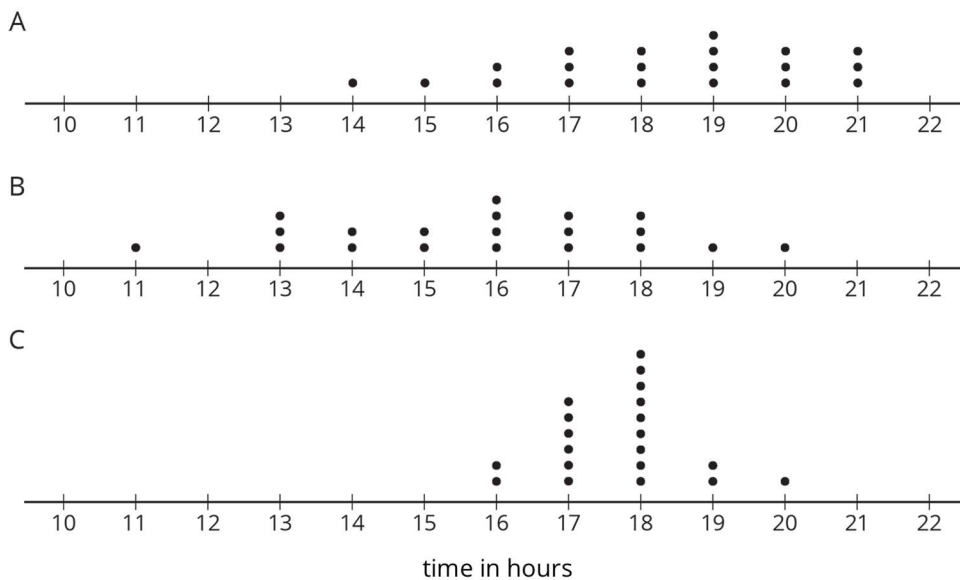
Solution

A is the dot plot for year 9.

B is the dot plot for year 7.

C is the dot plot for year 11.

Problem 2 Statement

Mai played 10 basketball games. She recorded the number of points she scored and made a dot plot. Mai said that she scored between 8 and 14 points in most of the 10 games, but one game was exceptional. During that game she scored more than double her typical score of 9 points. Use the number line to make a dot plot that fits the description Mai gave.
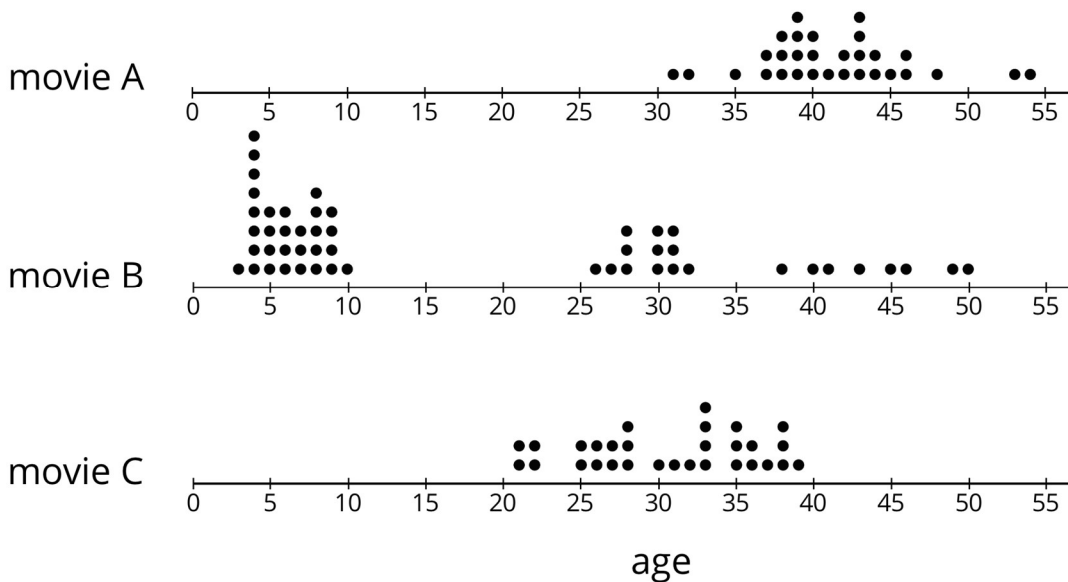
points
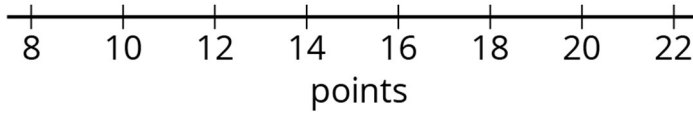
Solution

Answers vary. Sample response:

points
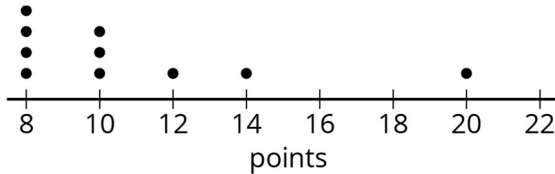
(Any dot plot that has most values between 8 and 14 and one value greater than 18 should be considered correct.)

Problem 3 Statement

A cinema is showing three different movies. The dot plots represent the ages of the people who were at the Saturday afternoon showing of each of these movies.

age

a. One of these movies was an animated movie rated U for any audience. Do you think it was movie A, B, or C? Explain your reasoning.

b. Which movie has a dot plot with ages that that centre at about 30 years?

c. What is a typical age for the people who were at movie A?

Solution

    a.   Movie B. There are many people with ages between about 4 and 10, and then ages that are between 25 and 50. This movie was attended by kids and the adults that were with the kids, so it is probably the U-rated movie.

    b.   Movie C.

    c.   A typical age would be around 40 years.

Problem 4 Statement

Find the value of each expression.

    a. $3.727 + 1.384$

    b. $3.727 - 1.384$

    c. 5.01×4.8

    d. $5.01 \div 4.8$

Solution

    a.   5.111

    b.   2.343

    c.   24.048

    d.   1.04375