

DMT INSIGHTS

Issue 29 · 2026 · by Jonathan Brendefur, PhD and Associates



UNDERSTANDING LINE PLOTS: CONNECTING DATA, QUANTITIES, AND FREQUENCY

What students need to distinguish when they read and construct line plots

Introduction

Line plots help students organize and examine numerical data. To interpret a line plot, students must understand what is being measured or counted, what each symbol represents, and how values and frequencies relate.

Students may correctly count the Xs on a line plot without understanding the quantities represented. For example, they may confuse the number of different values with the number of observations or interpret the most frequent value as the greatest value.

Understanding line plots involves examining the relationships among data values, frequencies, and the total number of observations. Teachers can develop these relationships through carefully selected representations, explicit instruction, student explanations, and feedback.

Key Idea • The position of an X shows a data value. The number of Xs above a value shows its frequency. Students need to interpret both.

Interpreting Values and Frequencies on Line Plots

Consider a line plot showing the number of books each of 8 students read this year (Figure 1). Students' responses to a plot like this can reveal difficulties distinguishing data values, frequencies, and the total number of observations. These distinctions are important because each describes a different quantity. A student who counts the five labeled

values on the axis and says, “There are five students,” has counted positions on the number line rather than the observations represented by the Xs. The total number of students is found by counting all of the Xs: $1 + 4 + 1 + 2 = 8$.

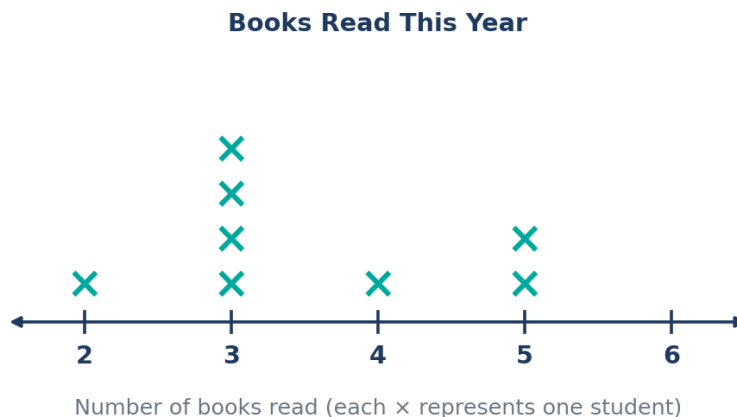


Figure 1. Books read by 8 students. Each X represents one student's response.

Quantity	What it describes	In Figure 1
Data value	The number of books one student read	2, 3, 4, or 5 books
Frequency	How many students reported a value	4 students read 3 books
Total frequency	The total number of observations	8 students
Most frequent value	The value reported most often	3 books
Minimum and maximum	The least and greatest observed values	2 books and 5 books
Range	Maximum minus minimum	$5 - 2 = 3$ books

Students may also misinterpret what an X represents, saying that each X is a book or that each X stands for two students. In this line plot, each X represents one student's response. Its position indicates how many books that student read. The number of Xs above a value gives the frequency of that response. A teacher might ask, “How many Xs are above 3? What does each one represent?”

Students may confuse the most frequent value with the greatest value in the data. In this line plot, 3 books is the most frequent response, with four students reporting that value. However, the greatest number of books any student reported is 5. Although 6 appears on the axis, no X appears above it, so no student in this data set reported reading 6 books.

The minimum observed value is 2 books, the maximum is 5 books, and the range is 3 books. These quantities describe different aspects of the data.

Labels and units also matter. If the axis does not say what is counted or measured, students may not know whether an X represents a student, a book, or a measurement. Friel, Curcio, and Bright (2001) describe how a graph's purpose, the task, and the reader's contextual knowledge influence how a graph is understood.

Bar graphs and line plots can both display frequencies. In a line plot, each X represents one observation. Its position identifies the observed value, and the number of Xs above that value represents its frequency. Students need to interpret both quantities.

Examining Students' Interpretations

Students may use familiar ways of interpreting graphs when examining a line plot. For example, they may focus on the tallest stack of Xs without distinguishing the most frequent value from the greatest observed value.

Student responses provide evidence of how they may be interpreting the quantities and relationships represented. Asking students what each X represents, what the axis numbers describe, and how they arrived at an answer can help identify which relationships need more instruction or practice. Jacobs, Lamb, and Philipp (2010) describe this work as professional noticing: attending to students' strategies, interpreting their understanding, and deciding how to respond.

Instructional Strategies

Teachers can begin by identifying the quantities represented in a line plot. In the books-read example, the horizontal axis shows the number of books read, and each X represents one student's response. The number of Xs above a value shows how many students reported that number of books.

Students can examine the original data, organize the observations in a frequency table, and construct a line plot. These representations show the same data in different ways. Teachers can use explicit instruction, questions, and feedback to help students interpret the scale, determine frequencies, and compare observed values. The choice and order of representations should depend on the mathematical purpose and students' prior knowledge.

Measurement data connect line plots to units and equal intervals. When students measure pencils to the nearest half inch, they partition each 1-inch unit on the number line into two equal intervals. Each interval represents one-half inch, and two such intervals compose one inch (Figure 2). This plot represents 13 pencils, and the most frequent length is $6\frac{1}{2}$ inches. No pencil measured $7\frac{1}{2}$ inches. The minimum is 5 inches, the maximum is 8 inches, and the range is 3 inches.

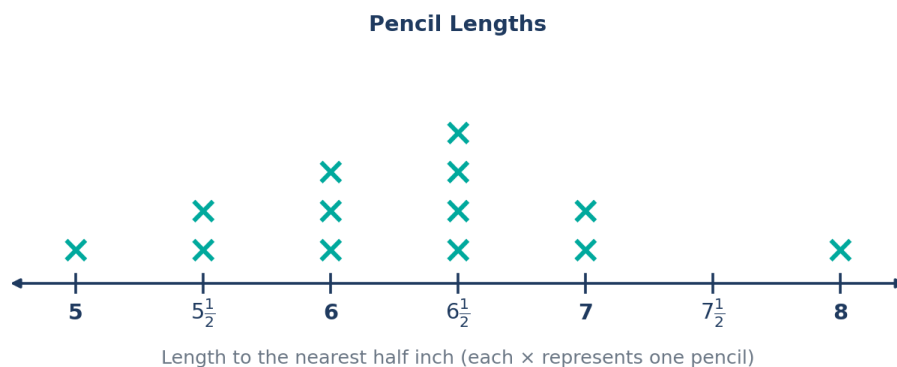


Figure 2. Pencil lengths to the nearest half inch. Each X represents one pencil.

Explicit attention to labels supports interpretation. Teachers can ask students to title the plot, label the axis with the quantity and unit, and state what each X represents. Feedback is most useful when it addresses students' reasoning as well as the correctness of an answer (Hattie & Timperley, 2007).

Questions That Reveal Students' Interpretations

Formative assessment gives teachers evidence they can use to adjust instruction (Black & Wiliam, 1998). With the books-read line plot, teachers might ask:

- What does each X represent?
- How many students read 3 books? How do you know?
- What is the greatest number of books reported by a student?
- How many students read 6 books? What does the empty position tell us?

Teachers should examine students' explanations before deciding what additional instruction is needed. A correct answer does not necessarily show how a student interpreted the representation, and an incorrect answer does not point to a single cause.

Key Idea • A student's answer is evidence to investigate. Ask what each X represents and how the student found the answer.

Developing Statistical Reasoning

Interpreting line plots involves more than identifying individual values. Students examine how observations are distributed across numerical values, identify which values occur most frequently, compare measurements, and describe how the data vary (Shaughnessy, 2007). In one study, fifth graders who measured plant growth and constructed their own displays developed ways to describe the center and spread of their data (Lehrer & Schauble, 2004). Watson and Callingham (2003) describe statistical literacy as developing across levels, from informal responses toward critical interpretation of data in context.

Teachers can connect these ideas to measurement, number lines, and operations. When students plot lengths measured to the nearest half inch, they must understand the measurement unit, the equal intervals on the number line, and the frequency of each measurement.

Summary

Line plots organize numerical observations and show how frequently each value occurs. Students need to distinguish an observation's value from its frequency, identify the units and scale, and explain how the data are distributed.

Teachers can develop these ideas through explicit instruction, carefully selected data sets, opportunities to connect representations, and feedback based on students' reasoning.

References

- Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, 5(1), 7–74. <https://doi.org/10.1080/0969595980050102>
- Friel, S. N., Curcio, F. R., & Bright, G. W. (2001). Making sense of graphs: Critical factors influencing comprehension and instructional implications. *Journal for Research in Mathematics Education*, 32(2), 124–158. <https://doi.org/10.2307/749671>

- Hattie, J., & Timperley, H. (2007). The power of feedback. *Review of Educational Research*, 77(1), 81–112.
<https://doi.org/10.3102/003465430298487>
- Jacobs, V. R., Lamb, L. L. C., & Philipp, R. A. (2010). Professional noticing of children’s mathematical thinking. *Journal for Research in Mathematics Education*, 41(2), 169–202. <https://doi.org/10.5951/jresmetheduc.41.2.0169>
- Lehrer, R., & Schauble, L. (2004). Modeling natural variation through distribution. *American Educational Research Journal*, 41(3), 635–679. <https://doi.org/10.3102/00028312041003635>
- Shaughnessy, J. M. (2007). Research on statistics learning and reasoning. In F. K. Lester, Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 957–1009). Information Age.
- Watson, J. M., & Callingham, R. (2003). Statistical literacy: A complex hierarchical construct. *Statistics Education Research Journal*, 2(2), 3–46.

Social Media

A line plot shows that four students read 3 books, while two students read 5 books. Which value occurs most often? What is the greatest number of books reported?

These questions examine different quantities. One asks about frequency; the other asks about the greatest observed value. This DMT Insight examines:

- How data values, frequencies, and the total number of observations differ
- What an empty position on a line plot represents
- How half-inch measurements connect line plots to units and equal intervals
- Questions that reveal how students interpret a line plot

Read the full Insight at mathsuccess.io/dmtinsights.

When your students read a line plot, can they explain what each X represents?

