

Using Slow Reveal Graphs to Build Data Literacy Skills and Increase Student Engagement

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ABSTRACT

Data literacy is an integral part of overall literacy in the twenty-first century. After participating in a National Science Foundation-funded BIORETS (Research Experiences for Teachers Sites in Biological Sciences) program that emphasized the importance of data literacy, I was motivated to focus more intentionally on data literacy in my middle school classroom. Providing students with strategies for making sense of data is an important component of data literacy. In an effort to develop this data literacy skill, I introduced Slow Reveal Graphs, a teaching strategy that promotes sensemaking about data. By removing contextual information from data visualizations presented in textbooks and the media and asking students to interpret the information as it is provided, students engage in problem solving, gain confidence, and grow their computational thinking skills. As a result, students engage more deeply with the content of graphs and other visual representations of data.

KEYWORDS: Graphing; Data Visualization; Data Analysis; Data Literacy; Slow Reveal Graphs; Student Engagement

Our modern society is steeped in data and graphic representation of data. Data literacy, making sense of information and “visual decoding” (Hunter-Thomson 2021), is an important skill for students in an increasingly technical and data-driven world. Helping students engage with data requires a set of skills that needs to be a routine part of curriculum. Informed decision making alongside the barrage of both information and misinformation in our society are reasons why our students need skills in data literacy.

Students’ interactions with data are multi-faceted, ranging from reading and creating graphs, to gathering data, and eventually interpreting information represented in a data set or visualization. Slow Reveal Graphs provide a teaching strategy where a complex graph or data visualization is dissected into limited pieces of information. These smaller pieces of information provide students with the opportunity to observe and analyze one critical component of a graph at a time.

For example, a graph might first be displayed with no information other than the distribution of data, no axis labels, and no indication of what the data are—only the pattern revealed by the data. More information is provided in subsequent “reveals” after students interpret the first reveal. Students are required to evaluate and possibly modify their understanding of the graph based on new information, thus promoting sensemaking of the data. Students gain much needed practice in analyzing data, distinguishing between correlation and causation, and using evidence to construct meaningful arguments.

Slow reveal graphs have many benefits in the classroom—the process is highly engaging, elicits curiosity, develops question asking skills, and promotes the use of inference as a part of analysis and interpretation of the evidence. Slow reveal graphs promote deeper understanding of complex relationships and patterns in data. The managed pace of the reveal allows students time to digest the information on each slide and make sense of the data without being overwhelmed by a complex figure.

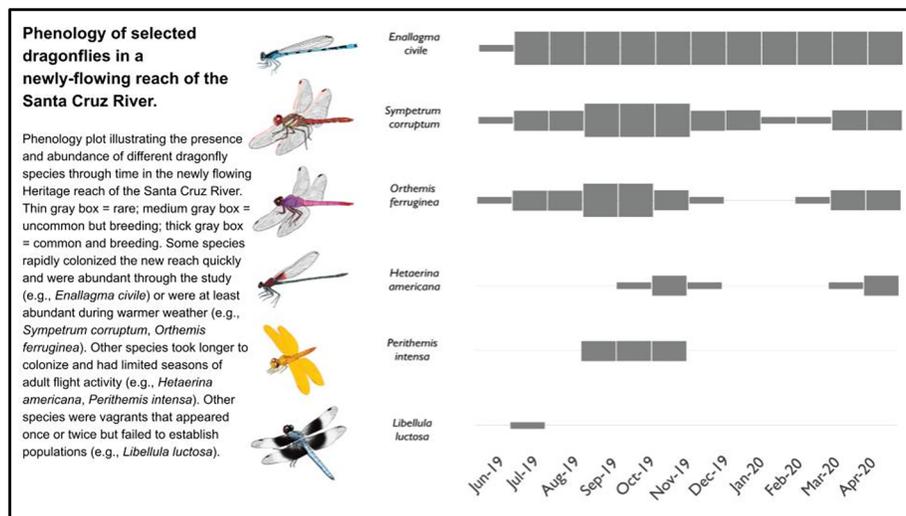
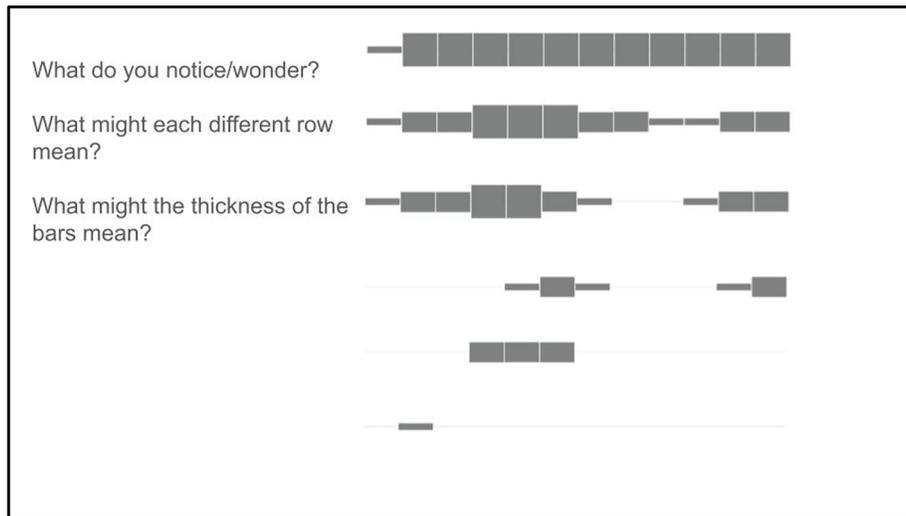
Implementing slow reveal graphs in a Middle school classroom

For middle school students, I primarily use two free resources found online: Slow Reveal Graphs and The New York Times Learning Network “What’s Going on in this Graph?” (see Online Resources for links to both). Even though the New York Times graphs are not formatted to be slow reveal, they can be downloaded into a presentation with details concealed and removed as you show more information. The Slow Reveal site has hundreds of examples, and teachers may develop their own Slow Reveal Graphs if they have a specific data set they want students to work with (Laib 2024a; see Figure 1). When selecting a graph, ensure the content of graph is appropriate, including culturally sensitive considerations.

Throughout the school year, every Friday is “graphing Friday” to give students consistent practice with data. These graphing activities can be mini-lessons or bell work, or they can be the focus that requires most of a class period. The lessons around Slow Reveal Graphs encourage independent student work, but I have also used these as small-group practice, which promotes collaboration and consensus building. Middle school students can be very competitive and like to be “right” so they are very invested in Slow Reveal Graph lessons and the outcomes. For them, it’s about being correct; for me as the teacher, it’s getting students to use the power of observation and questioning, and then putting it all together to make a plausible “story” for the data.

For small-group activities, students are not grouped by ability. Each table (group) may have on-level and higher achieving/gifted students, English language learners, and students who may need more academic support. The conversation among students helps all learners, either with vocabulary, concise expression of ideas, explanations, or summarizing thoughts. I roam the room, modeling what types of questions to ask: *Why do you think that? Could you provide evidence from the graph to support your statement? What led you to that conclusion or input?*

FIGURE 1: Complex Slow Reveal Graph based on research article (Laib 2024a).



During these activities, I gauge student participation. Students fill out individual graphic organizers (see Figure 3) to demonstrate their learning and receive a separate grade for their participation in their small group. Following are some ways students demonstrate accountability in small-group work:

- everyone writes an individual idea that could lead to group consensus or disagreement
- each student completes a graphic organizer
- teacher monitors and moderates student groups
- students practice small group teamwork with each activity.

Differentiation strategies vary depending on student needs. If writing is a challenge, students may provide oral contributions. Utilizing think-pair exercises, where one student verbalizes and the other writes, can be used. Another option is having English language learners write in their preferred language.

Data interpretation and graphing are mostly visual input—what we see and are making sense of. I ask my students to do three things for each Slow Reveal slide: make two observations, write one question, and write one inference (Carpenter 2023; see Figure 3). The observations are anything students see or notice. Examples include noticing color, noticing

the shape of the graph, naming the type of graph (bar, line, pie chart), and more. Anything students see on the slide can be an observation, and students are reminded to look closely for details. See Figure 2 for an example of the first slide of a Slow Reveal Graph.

Next, students write down one question on their graphic organizer (see Figure 3) about what has been revealed on the first slide or part of the graph. Students are not allowed to write general questions such as “I wonder what the graph is about?”; their question must lead to discovery. By requiring that a question leads to discovery, students are developing productive and meaningful questioning skills. Examples of productive questions include: “I wonder if the color of the bars has anything to do with the data in the graph?” and “I wonder why all the points in the graph are clustered together?” Student generated questions can lead to a false interpretation, which is okay—students are taking academic risks. When students engage in question generation, they gain practice in an important data literacy skill. Often, I have students share their questions and ask them, “What about the graph led to your question?” Teachers can also challenge students to clarify their observations and inferences by asking where they got their information. The key for teachers is promoting critical thinking and getting students comfortable with citing evidence, whether it is in graphs, data, or text. This is a good time to also work with students on their academic vocabulary relating to data. Students say, “I observe something going up and down,” but with practice and scaffolding, they will understand the importance

FIGURE 2: Slow Reveal Graph slide 1 with minimal information [Laib 2024b].

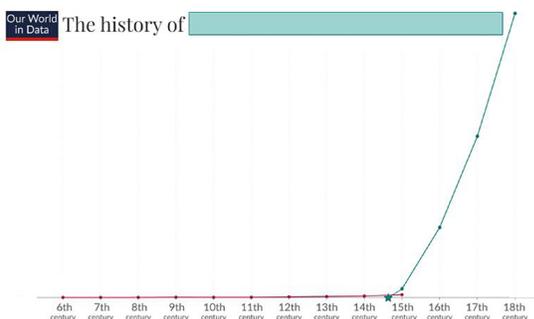
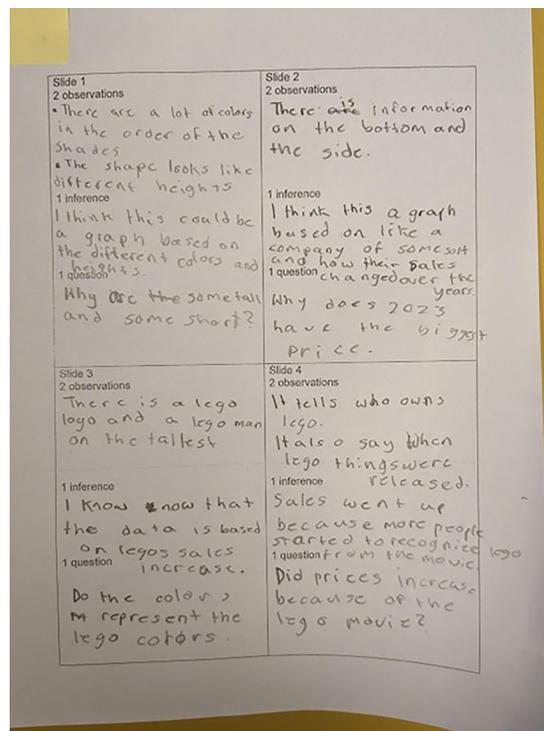


FIGURE 3: Example of student graphic organizer for Slow Reveal Graph with student responses.



of more precise language such as “I observe something increasing and decreasing.”

For both middle and high school students, the type of graph presented might generate questions. Most students are familiar with bar graphs, line graphs, and pie charts. Once all the information is revealed, these can be relatively easy to interpret. With more complex graphs such as box and whiskers plots (see Figure 1), scatter plots, or even graphs such as Lupi and Posavec (2016) present in Dear Data, students will have to think deeply about the mean, mode, and median and what the graph represents. Dear Data documents a yearlong exchange of postcards with hand-drawn, highly complex visualizations of daily life data. Data analysis and interpretation go far beyond average reported values, and students must expand their data literacy skills to be able to understand the information (Lipson 2023).

For data science skills that go beyond the *x*- and *y*-axis, teachers need to introduce different kinds of

graphic representations as well as aspects of data science such as quartiles, variability, and skewness. Slow Reveal Graphs are amenable to data complexity, such as the Slow Reveal dragonfly graph (see Figure 1), and can be used as enrichment for higher achieving students.

The final task for students is to draw inferences from the information presented. This can be tricky for many students. I begin with a definition of inference: the hidden story that you have to figure out given the available information and what you already know. Every graph has a story (Hogan 2022), and students must find out what that story is. Students must back up their interpretation with evidence from the graph. Often students will be wildly incorrect after the first slide with limited information, but as more details are revealed, the story becomes clearer. This keeps students engaged in the lesson, partially because they want to be correct and to outperform their peers. This is especially true if the teacher sets up teams and students collaborate to analyze the information and interpret the graph.

After modeling an inference based on evidence such as “This graph has something to do with the season based on the orange color of the bars,” students will write on their graphic organizer. All student interpretations of the early slides are considered

valid and appropriate as long as they have sufficient evidence. Students should not erase early guesses as this shows their early exploration and demonstrates how thinking can change based on more information. A comparison of their inferences from the first and second slides to the final slide shows students that they have learned and processed new information (see Figure 3). I often hear a lot of “I get it now!” kinds of comments at the end of the Slow Reveal Graph lesson (see Figure 4). The more students practice obtaining and synthesizing evidence, the better they become at noticing details and inferencing.

I use many different kinds of graphs in my science classes. I want my students to think critically about both the data and the topic. Understanding how the numbers and information were collected and presented, along with their meaning, is key. But I also want them to gain insight about the topic of the graph. In one lesson, the simple bar graph indicated an increasing/decreasing trend. One student inferred “I see that the population of a species is increasing and decreasing over time” in part because we were studying invasive species. Her observation of the increase and decrease was accurate, but the graph was about incidents of bullying and the locations in a school where bullying occurred (see Figure 5). As the most contextual slide was revealed, student reactions gave

FIGURE 4: Slow Reveal Graph with all information [Laib 2024b].

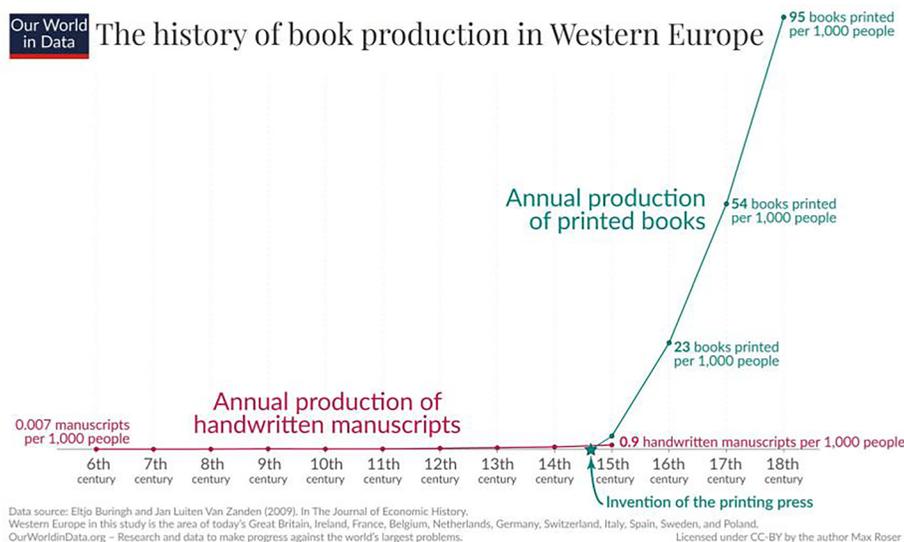


FIGURE 5: Slow Reveal Graph [where bullying occurs]. First slide on the left shows only bars. The fifth and final slide [right] in the presentation reveals all of the information [Laib 2023].

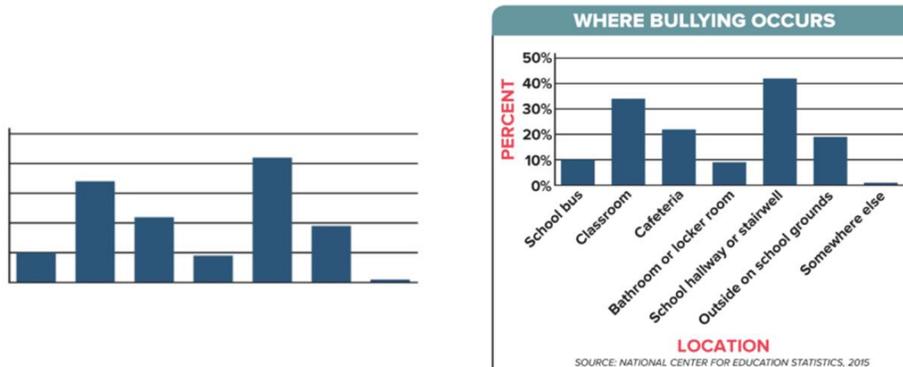


FIGURE 6: Rubric for assessing graphic organizer completed by students.

Skills	Exceeds	Meets	Approaching	Not met
Observations and questions	Observations and questions lead to discovery. Seeks and clarifies additional information and details. Evaluates and reflects on questions and information.	Makes observations and asks questions to seek additional information. Asks clarifying questions.	Asks questions about the data or graph. Makes cursory observations.	Asks questions based on observations. Limited or no observations of graph. Does not ask clarifying questions.
Analysis and interpretation	Compares/contrasts information. Uses data to make conclusions. Uses quantitative data to support conclusions. Makes inferences about each slide	Analyzes/interprets data from the slide. Uses slide information to make conclusions. Provides evidence from graph.	Understands information on each slide and connects it to graph. Attempts to build a coherent explanation.	Limited or no analysis or storyline for slides. No connections made between slides or data on each slide.
Using patterns and information to identify relationships	Identifies, analyzes, and uses patterns to associate data with trends and relationships. Accurately interprets and describes relationships between each slide using evidence. Can formulate some cause/effect relationships in data.	Identifies and describes patterns in data. Describes relationships between slides. Makes some predictions based on information.	Identifies obvious patterns or trends. Limited description of relationships in graphs or between slides.	Does not identify patterns or trends in data. Does not make connections to identify relationships in graphs or between slides.

me insight that this was a meaningful topic for them. The conversation after the last slide was equally revelatory. Students were hypothesizing why more bullying occurred in the hallways and stairwell than in the bathroom or off-campus. They were able to relate the data to their own school experiences, discussing both school rules about bathroom use and how passing period is where a lot of student interaction occurs. They were making sense of the data and comparing the evidence to their own observations. I suggested that we could collect data about bullying at our school, create a graph, and present the data to school administrators or the student leadership club. In this way, we would be using data in a meaningful, positive, and personal way, building student engagement and interest.

Impact on students

The more that students work with data collection, organization, and visualization, the more comfortable they are with data inquiry, a topic that can seem daunting. The ability to observe and question is critical to scientific thinking, as is being able to infer accurately based on evidence. I display on my class objectives board an image of a graph from a local television station that is carelessly made and

inaccurate. The news agency's inability to create an accurate wind-speed graph is a prime example of the need for teaching data literacy. This graph is a great starting point for students to understand not just the importance of data literacy, but also the importance of being careful consumers of information.

Slow Reveal Graphs make data literacy an accessible subject for both teachers and students. These lessons go hand in hand with teaching descriptive statistics such as mean, median, mode, and range in middle school. Making data inquiry a mystery to be solved engages students in this important and essential subject.

Future development

I will continue to expand my collection of Slow Reveal Graphs. We do a unit based on Dear Data (Lupi and Posavec 2016) that is focused on creative ways to communicate data through visual art. As an enrichment project for my high-level students, I would like them to make their own Slow Reveal Graphs, as the graphs they have created for our Dear Data lessons (using personal or provided data) are amenable to slow reveal graphing. Students would then present their graphs and lead their classmates through the lesson, asking clarifying questions and working up to revealing the data. This would encourage building

FIGURE 7: Rubric for assessing small-group work.

Skills	Exceeds	Meets	Approaching	Not met
Contributions	Gave input, ideas, or evidence. Did more work than others. Led or co-led group.	Gave input or ideas, shared work with others equally.	Gave minimal input. Shared few ideas. Few contributions.	Gave no input. Did not contribute ideas.
Cooperation and collaboration	Allowed others to speak and share. Stayed focused on group goals.	Helpful and involved in task. Generally focused on group goals.	Minor involvement with little benefit to group. Mostly not focused on group goals.	Uncooperative. Argumentative in unhelpful ways. Condescending.
Feedback and teamwork	Asked questions and clarified. Supported others with positive feedback.	Asked some questions, provided some feedback. Mostly supportive.	Little helpful feedback. Often off task. Asked 1 question	Feedback not given or unhelpful. Did not contribute to group goal. Off task.

classroom community, as students would learn new information about each other (see rubrics in **Figures 6** and **7**; see the NGSS chart in Supplemental Materials). By using Slow Reveal Graphs regularly in my classroom, my students are better able to interact with and learn from data. Slow Reveal Graphs are a tool that consistently builds connection, curiosity, and deepens students' data literacy skills. ●

FUNDING

This article is based on work supported by the National Science Foundation under Award No. 2143228 and No. 2444231, BIORETS: Conserving Water Resources and Riparian Biodiversity in a Desert Climate. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author[s] and do not necessarily reflect the views of the National Science Foundation.

SUPPLEMENTAL MATERIALS

Connecting to the Next Generation Science Standards—
<http://doi.org/10.1080/08872376.2025.2601361>

ONLINE RESOURCES

Slow Reveal Graphs—<https://slowrevealgraphs.com>
The New York Times Learning Network: "What's Going On in This Graph?"—<https://tinyurl.com/mwkhxwu8>

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