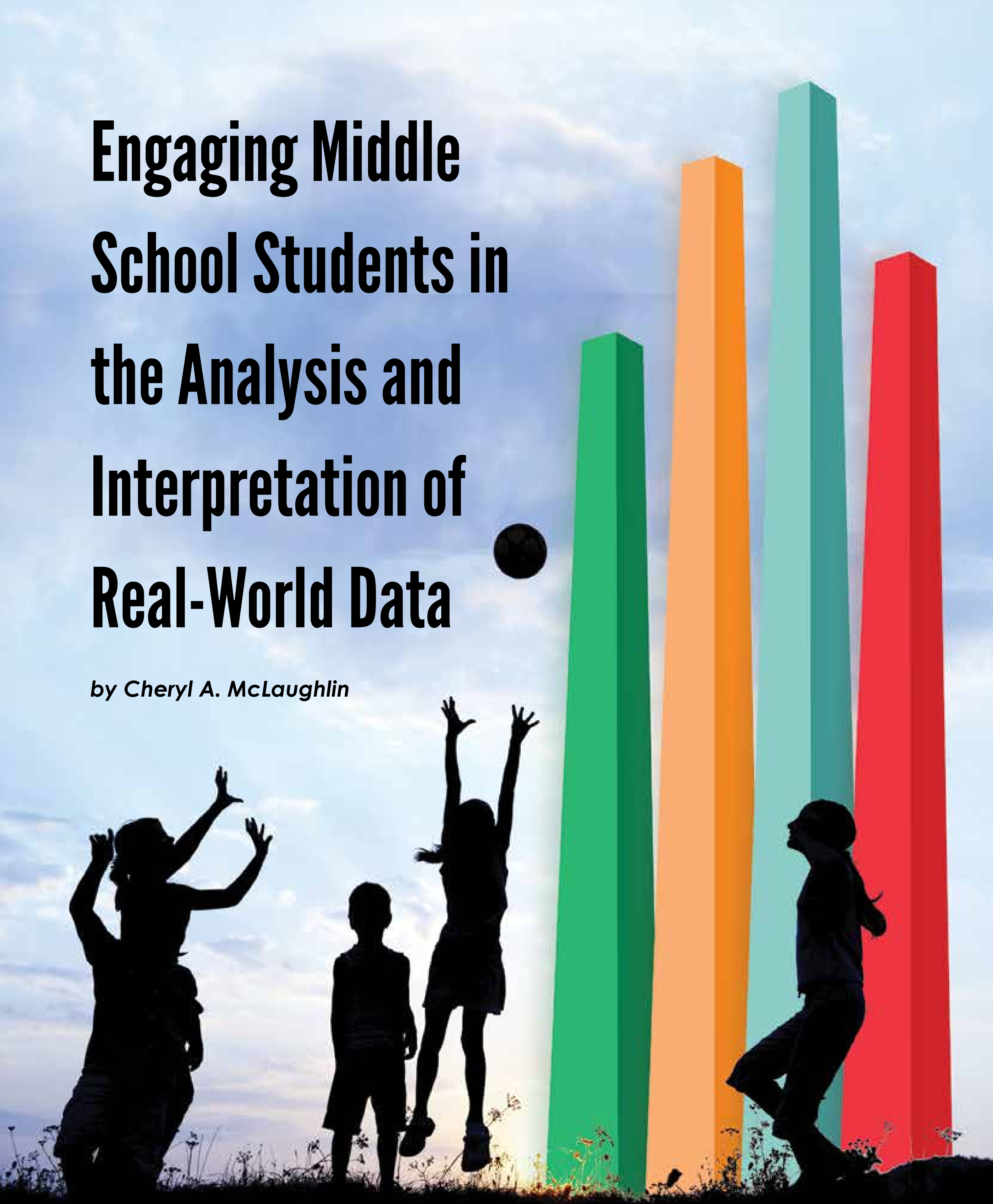


Engaging Middle School Students in the Analysis and Interpretation of Real-World Data

by Cheryl A. McLaughlin

This article describes how I engaged sixth-grade students in the analysis and interpretation of real data presented in scientific articles written specifically for middle school students. The *Natural Inquirer* (*www.naturalinquirer.org*) is a free journal designed to share, with middle school students, scientific research conducted by scientists in the USDA Forest Service. Each article has (1) a section called "Meet the scientist," which introduces students to the scientists who conducted the research, (2) general information about science and the environment, (3) a report of the research conducted written in a format similar to that of scientific journals, and (4) instructional resources to assist teachers and students who use the journal. After students read the research presented in one of these articles, I gave them an opportunity to make claims about the data presented and to provide evidence in support of their claims.

The 90-minute lesson presented here incorporates scientific practices emphasized in the *Next Generation Science Standards (NGSS)*, including the analysis and interpretation of data, as well as the construction of scientific explanations based on evidence (Achieve Inc. 2013). The lesson also supports the idea that students should be encouraged to read about current scientific research and be taught to make sense of the findings presented.

The lesson

This lesson uses a feature article published in the *Natural Inquirer* titled "Time Out! How Much Time Do Kids Spend Outdoors?" (Larson, Cordell, and Green 2012). Rather than providing them with the entire research report, I first had each student read the two-page introduction to the report and gave them three prompts to respond to in their science journals. The introduction provides the context of the research by highlighting scientists' wonderings about the amount of time kids spend outdoors, as well as how these questions may be addressed through research. The introduction also describes the ways in which the research findings could benefit recreation managers. These three prompts, which are included in the article (Larson, Cordell, and Green 2012, p. 12), can be modified to align with specific investigations, whether they are reported in other scientific research or conducted by students in the lab:

- What are the questions the scientist wanted to answer?
- If you were a scientist wanting to learn about kids' time outdoors, how would you go about gathering the information?
- Why do you think understanding kids' time outdoors would help recreation managers?

During this activity, I asked students to underline or highlight portions of the article's introduction that address the prompts before writing the responses in their journals. In so doing, I was able to attend to students' misunderstandings that may have emerged from the reading of the article. I also asked them to highlight vocabulary from the article's introduction that they were unfamiliar with. During a whole-class discussion, students shared their responses with their peers and the new vocabulary words were added to our class word wall. New vocabulary words, such as *demographic*, *baseline*, and *recreation manager*, were briefly discussed to provide further clarification for students. The purpose of the reading activity was to familiarize students with the background of the research in order to facilitate the analysis of the data generated as a result. (See sidebar for connections to the *NGSS* and *Common Core State Standards*.)

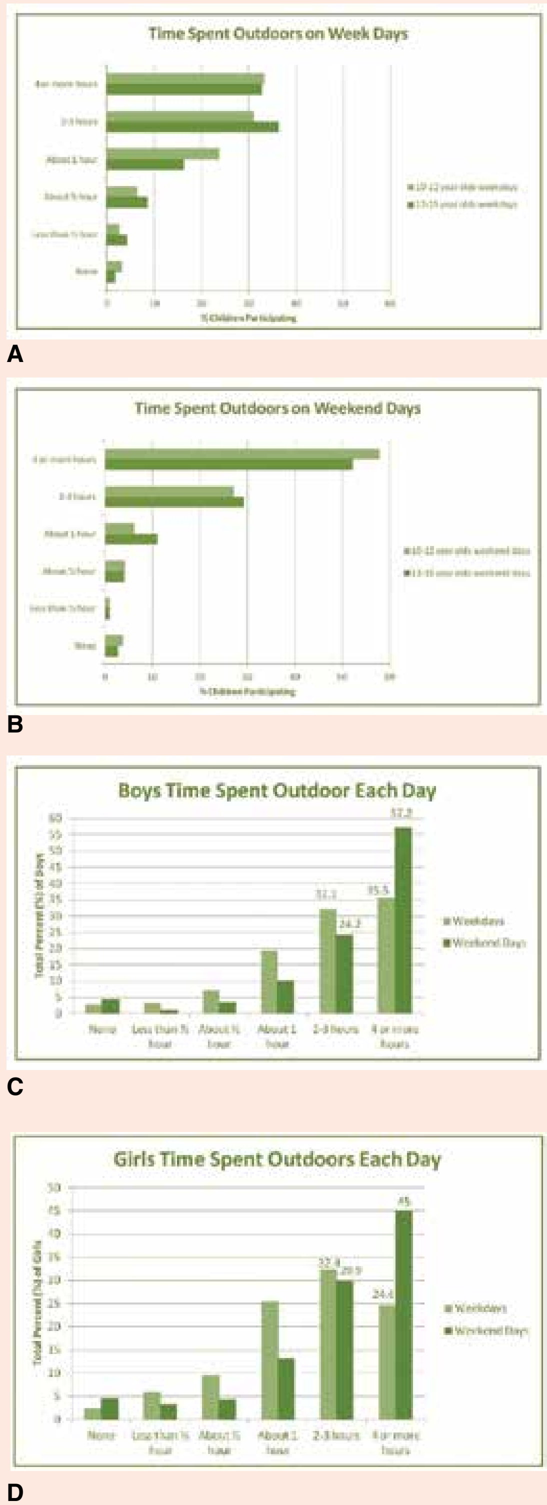
The other focus of the lesson was to have students examine the graphical representations of the data in order to gain a preliminary understanding of the findings. Although the article presents methods and explains the findings, I wanted students to analyze and interpret the data independently before reading the explanations provided. The class was divided into eight groups of at least three students, and each group was given a single bar chart that was obtained from the research report. Four *different* bar charts were used for this activity, so two groups were working with the same

data set (Figure 1A–D). The bar charts present findings as follows: time spent outdoors on weekdays (Figure 1A), time spent outdoors on weekend days (Figure 1B), boys' time spent outdoors each day (Figure 1C), and girls' time spent outdoors each day (Figure 1D). I asked students to work in groups to write down two claims that could be made about the graphs they examined by saying, "Please look at the bar charts and write down two claims about the kids in the study and the time that they spend outdoors. Remember to look at the title of the graph as well as the *x* and *y* axes in order to help you understand what the graph is telling us." My students had already drawn bar charts in previous classes, so they were relatively familiar with the use of bar charts to communicate information. Each group was given chart paper and a marker to record students' ideas. Some students experienced difficulties in writing their claims, so I moved around the room to provide support for student groups by asking probing questions and providing prompts such as "What can be concluded from the information generated from the bar chart?"; "What have you learned from the data presented in the bar chart?"; and "Write a sentence summarizing the ideas presented in the bar chart."

Despite the fact that two groups worked with the same data sets, the claims were diverse and represented students' developing understanding of the results presented. These included the following: "Many kids ages 10 to 15 years old spend time outdoors on weekdays"; "A few kids between 10 and 15 years old do not spend time outdoors on weekend days"; and "More boys spend time outdoors on the weekend days that on weekdays." After approximately 20 minutes, I asked groups to share their claims in order to ensure that they reflected the data contained in the bar charts. As each group shared its claims, I checked for consensus among the rest of the students by asking, "Do you agree?"; "Is there anything you would like to add?"; and "Are there any suggestions for change?"

The next stage of the lesson involved having students present evidence to support the two claims they made. I asked, "Now that you have decided on your claim, what specific data can you present from the bar charts to support the statement you wrote? Look at the bars from the graph you used to help you with your claim, and write a complete sentence to say why the claim you made is true." I encouraged students to use some of the numerical data presented on the bar charts to help them. One student asked if it were possible to have two pieces of evidence to support a single claim. I explained that it was indeed possible and encouraged them to write down as many pieces of evidence as they could find. The examples included here correspond

FIGURE 1 Data from the article used in class (Larson, Cordell, and Green 2012)



Standards

This lesson aligns with the following performance standards of the *Next Generation Science Standards* (Achieve Inc. 2013):

1. Analyzing and interpreting data. Analyze and interpret data to provide evidence for phenomena.
2. Constructing explanations and designing solutions. Construct a scientific explanation based on valid and reliable evidence obtained from sources (including students' own experiments) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.
3. Engaging in argument from evidence. Construct and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem.

This lesson aligns with the following *Common Core State Standards* (NGAC and CCSSO 2010):

English language arts

1. CCSS.ELA-Literacy.RST.6-8.5. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic.
2. CCSS.ELA-Literacy.RST.6-8.6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.

Mathematics

1. CCSS.Math.Content.6.SP.B.4. Display numerical data in plots on a number line, including dot plots, histograms, and box plots.
2. CCSS.Math.Content.6.SP.B.5. Summarize numerical data sets in relation to their context.

with the claims presented in the previous paragraph: "Over 30% of kids between ages 10 and 15 in the study spend four or more hours outdoors on weekdays"; "Less than 5% of kids in the study do not spend time outdoors on weekend days"; "On weekdays, 35.5% of boys spend four or more hours outdoors, and 57.2% of boys spend four or more hours outdoors on weekend days." As students discussed their evidence, I moved from group to group, spending extra time with groups that were struggling with finding appropriate evidence. In order to provide extra scaffolding, I tried to focus students on the parts of the data that addressed the claim (student responses are in parentheses):

- "OK, let's start by looking at your claim. You said that more boys spend time outdoors on weekends than on weekdays, right?" ("Yes.")
- "Let's look at the key; what does the darker color represent?" ("Weekend days.")
- "What does the lighter color represent?" ("Weekdays.")
- "What percentage of boys does each bar represent?" ("It's 35.5% for weekdays and 57.2% for weekends.")
- "Good. So what can we say about the number of boys who go outdoors on weekends and weekdays?" (Students were asked to write down the evidence to support each claim on the chart paper provided.)

The two groups of three students who worked on the same bar chart were consolidated into larger groups of at least six to brainstorm possible reasons for the trends they were observing in each of the data sets they looked at. For instance, I asked, "Why do you think they were spending this time outdoors? What are some of the things they might be doing? What might be preventing some kids from spending more time outdoors?" These questions were written on the board to guide students' discussion. Again, students' ideas were recorded on chart paper and included responses such as the following:

- "Kids ride their bikes outdoors."
- "Kids take walks with their parents."
- "Kids play in the park."
- "Some kids stay inside to play video games."
- "Some kids are not allowed to go outside without their parents."

After the brainstorming session, I provided students with the "Findings" section of the article, which summarizes the research results illustrated in the bar charts and also lists the most common activities that

FIGURE 2 Rubric used to assess group work

	Excellent	Good	Fair
Makes a claim from the data.	Makes an accurate claim.	Makes a claim that reveals partial understanding of the data.	Makes an inaccurate claim.
Provides evidence for the claim.	Provides accurate and sufficient evidence for the claim.	Provides some accurate evidence for the claim, but it is inadequate.	Provides inaccurate evidence for the claim.

kids engaged in outdoors. Students were able to compare their own claims to those made by the scientists who conducted the research. The similarities between students' claims and those presented in the "Findings" section validated some students' interpretations, and also provided other claims that were not immediately apparent to students through their examination of data. Students were asked to underline those claims made by the researchers that were not presented by the student groups.

After students identified researchers' claims, we engaged in a whole-group discussion, during which students shared new findings on the experiment. I asked, "What other information does the graph communicate that we have not yet discussed?" Students read aloud some of the highlighted segments: "Kids ages 6–12 spent more time outdoors on weekends than kids ages 13–15" (Larson, Cordell, and Green 2012, p. 15).

"Good," I said. "Show me the evidence from your bar chart to support that." Students pointed to the bars (see Figure 1B), indicating, "See, the bar for 10- to 12-year-olds is longer than the bar for 13- to 15-year-olds."

I responded, "Yes, and what specifically is this telling us? What does the longer bar tell us?"

One student said, "The longer bar means there are more kids spending time outdoors."

I probed, "Anything else?"

The student replied, "The shorter bar is for the 13- to 15-year-olds, so that means that less of them spend more than four hours outdoors compared to 10- to 12-year-olds."

To check for understanding, I asked, "Does everyone agree?"; "Any other thoughts on this claim?"; and "Any other evidence to support this claim?" I assessed the partial scientific explanations (claims and evidence) students wrote using a rubric (Figure 2) that evaluates students' understanding of the scientific practice that they engaged in (Krajcik et al. 2006). These scientific practices aligned with those emphasized by the *NGSS* and *A Framework for K–12 Science Education* (Achieve Inc. 2013; NRC 2012).

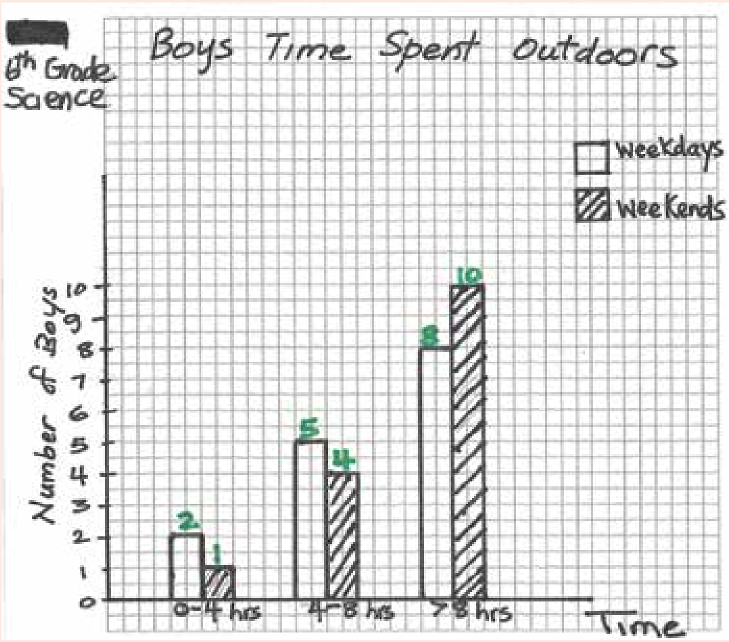
FIGURE 3 Student survey

Instructions: Check the response that applies to you.

1. Gender
   ❑ Male ❑ Female
2. How much time did you spend outdoors on a weekday last week?
   ❑ 0 to 2 hours ❑ 2 to 4 hours ❑ 4 or more hours
3. How much time did you spend outdoors last weekend?
   ❑ 0 to 2 hours ❑ 2 to 4 hours ❑ 4 or more hours

As an extension to the lesson, I gave students a survey (Figure 3) to complete in order to determine the amount of time their peers spend outdoors on both weekdays and the weekend. After they completed the survey, we tallied the results during a whole-group discussion and posted them on two data tables—one for boys and one for girls. All students were asked to draw bar charts to represent both data sets, write one claim for each, and provide one piece of evidence in support of their claims. As students drew their bar charts, I walked around the room to ensure they were on task and to answer questions posed by students who were experiencing difficulties. After approximately 25 minutes, when students had completed their bar charts, I asked, "How do our results compare with those of the study reported in the article? Are they similar? Are they different?" Our class data indicated that both boys and girls spend more time outdoors on weekends than on weekdays (Figure 4)

FIGURE 4 Sample of student bar chart



and mirrored the findings of the authors of the article. During our ensuing discussion I asked, "What if our class data were different? How could we explain that?" Students had several possible explanations, including the following: "Perhaps students in our class live in neighborhoods that are different from the ones the kids in the study live in"; "If it snows all the time in the state where those children live, then the results would be different because it doesn't snow in this state"; and "It also depends on what time of year they did the survey." As students shared their ideas, I encouraged whole-class participation by asking students to share ideas that were different from the ones being advanced.

In summarizing the day's lesson, I explained the importance of verifying information presented in articles by examining the data or evidence used to support the claims authors make. For instance, a company may claim that its tutoring services boast a 95% pass rate for students taking the SATs. This information must be critically examined for its veracity, because the data may have been generated from students who are from a certain socioeconomic background and who are receiving other academic supports to ensure success in these exams. The claims made would therefore not be representative of all students in the United States taking the SATs. Students were encouraged to carefully examine claims made in media or print before accepting them as credible or reliable.

As a wrap-up activity designed to have them reflect on the relevance of this activity to their everyday lives, I asked students to record in their journals two ideas they learned from our class activity that they could consider the next time they read about scientific research online or in print. Although the lesson's focus was on the analysis and interpretation of real-life data, I wanted students to gain an appreciation of the importance of being critical consumers of the information they access on a daily basis. This journaling activity stimulated reflection as students connected the lesson to their everyday lives. *A Framework for K–12 Science Education* (NRC 2012) supports this lesson's goals of preparing students to engage in public discussions on socio-scientific issues, and to make critical decisions regarding science-related concerns in their everyday lives. ■

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