"ACCELERATING" SCIENCE LEARNING WITH READING

BY PATRICK BROWN

CONTENT AREA

Science and English language arts

GRADE LEVEL

8

BIG IDEA/UNIT

The relationship between forces, mass, and acceleration (Newton's second law)

ESSENTIAL PRE-EXISTING KNOWLEDGE

There is a direct relationship between the slope of a ramp and the acceleration of a car.

TIME REQUIRED

One 50–60 minute lesson

COST

Approximately $7 per student for five highlighters (Note: Students could also share highlighters to cut cost.)

How do you read a difficult science text? Do you underline and highlight key parts and use context clues to decipher unknown words and concepts? Do you annotate sections by jotting down ideas and listing questions? Do you read the text more than once, focusing on what you know and need to figure out to understand the reading? Although these are the strategies expert readers use, I find that many students who are novices have difficulty learning content and learning to read from science texts. This article describes my physical science students learning about forces, motion, and acceleration and emphasizes using close analytical reading to help students explain science concepts.

Prereading activities

Prior to reading, students participated in a number of laboratory activities designed to elicit their knowledge, including misconceptions, and motivate their learning through experiences that produce data (Bybee 1997). Students used cars, ramps, and timers to investigate many questions such as whether changing the ramp angle influences the speed of a car. They tested how adding to and subtracting from the mass of a car affects how fast a car will travel down a ramp, explored how manipulating the force used to pull a car impacts the car's acceleration, and considered whether adding a source of air resistance (i.e., attaching a paper plate to a car) changes the speed at which a car travels. Students also worked collaboratively to collect and organize data in tables and made scientific claims about all of the research questions previously listed. From these investigations, students explained the relationship among speed, force, mass, and acceleration.

Reading about physics

Students' firsthand experiences with data and evidence were important for developing science vocabulary knowledge and conceptual understanding of how forces acting on an object influence motion. Following the hands-on laboratory activities and data analysis, students used a portion of the article "Thinking about Physics While Scared to Death (on a Falling Roller Coaster)" (Walker 1983) to develop deeper understanding of acceleration and speed. The article is challenging for students because it uses complex academic and discipline-specific vocabulary and requires extensive knowledge of science concepts (NGAC and CCSSO 2010). To engage with the article, students used a close-reading strategy called the Five S strategy (Nyberg and Shelnut 2004). *Close reading* is a scaffolded activity where students interact with the text individually, with peers, and with the teacher to jot down notes, highlight, and annotate to develop deeper understanding. The Five S strategy requires students to read the text using the following analytical lenses: structure, speaker, situation, shifts, and summary statements. The specific analytical "S" of each lens became the reading activity versus the product of the reading. Thus, the Five S strategy provided students with a method for engaging in the intricacies of text and exposed them to multiple perspectives to develop deeper content and literacy understanding.

Implementing the Five S strategy

The activities associated with the reading took approximately 35 minutes. Students worked in groups of four that included high- and regular-ability readers challenged with the task to read or carefully skim the entire article versus focusing on only a small part of the text. During the close reading, all students read and discussed the article. Students read the entire article during the first analysis and then closely skimmed the article for each subsequent close reading. Next, students rotated among five different tables that were labeled with their position in the reading sequence (i.e., 1, 2, 3, 4, and 5) and the specific "S" analytical lens. Students were instructed to go through the tables sequentially according to their number. In addition, each numbered station had specific guiding questions (see Figure 1) and a particular highlighter color so students could indicate their comments, ideas, and markings associated with the perspective on the article. As students became familiar with the text, they could more easily reread with a new and different purpose, so less time was needed to complete each task as they progressed through the stations. As students moved from station to station, they quickly realized that their goal (the purpose for reading) changed each time. Students were pleased to see that although their goal changed for each "S" phase, their familiarity with the article allowed them to quickly hone in on the new reading task and develop deeper understanding from each reading. Each rereading maintained student interest and motivation because it was a new intellectual task that directly tapped into their prior knowledge and developing understanding.

The first S: Structure (10 minutes)

The purpose of the analytical lens of structure was to develop students' understanding of the layout of the

passage. During this time, students paid particular attention to key areas and concepts and accompanying figures, tables, and diagrams. At first glance, students noticed the text excerpt only had a title and a figure and no headings or subheadings to guide their reading. They inferred the texts were arranged in "different paragraphs" and "all about relatively the same topic." Students drew on the figure to identify the keywords "acceleration" and "speed" because key terms were not identified by bold or italic fonts. Students also made connections between the figure and accompanying explanatory text. Students were asked to describe how the figures related to the narrative portion of the text. Students commented that the figure was showing a moving, accelerating object, which was being explained by the author in his writing. Understanding how a text was structured gave students a greater appreciation for how tables and figures can provide valuable information and can be just as important as the narrative.

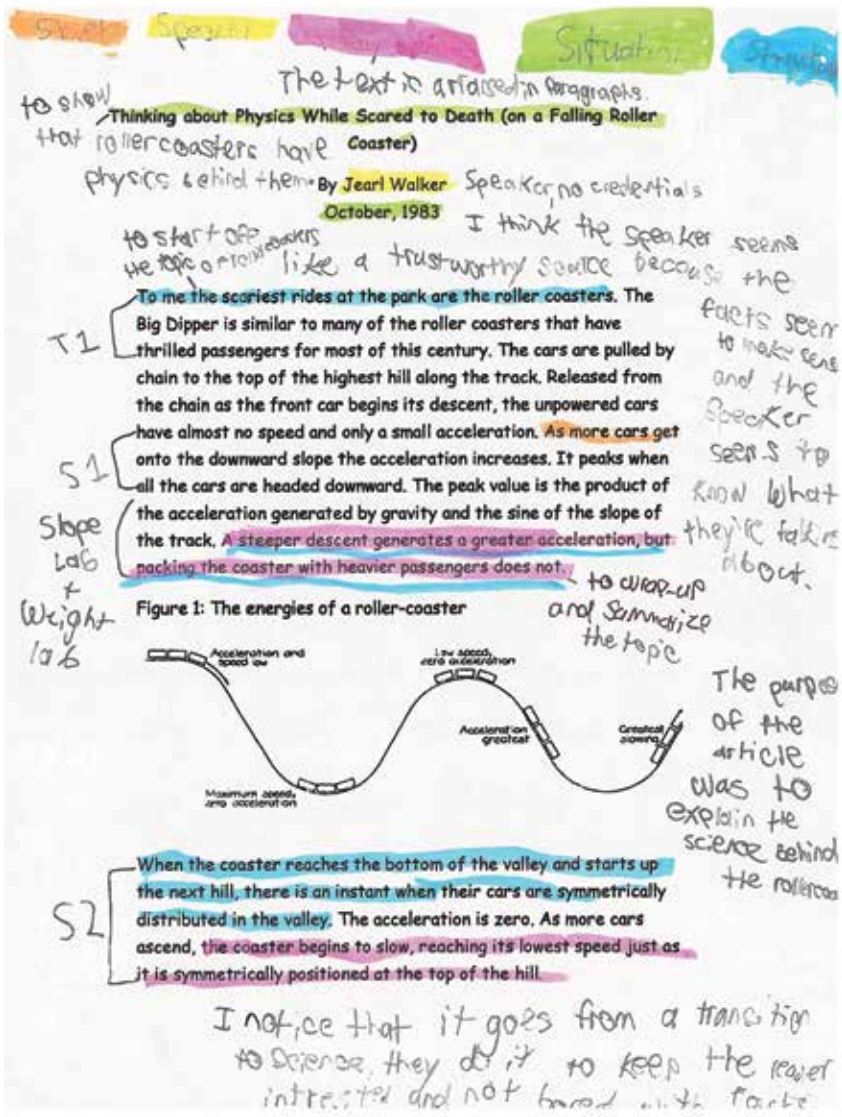
FIGURE 1: The Five S lenses and representative probing questions

"S" Lens	Reading tasks/probing questions
Structure	**Skim the text** • How is the text arranged? • Are there headings? If so, what are the levels of headings? • Are there figures, tables, graphs, or sidebars that accompany the text? • Are there important terms? • Can you determine whether there are "key" sections or sentences?
Speaker	**Analyze the text for the author's point of view** • Who is the speaker? • What are the speaker's credentials or title? • What inferences can you make from the provided information about the speaker? • Can you trust the speaker? • What is the speaker's attitude and tone?
Situation	**Read the text for main ideas** • When was the article/book/excerpt written? • What was the purpose of the document? • What motivated the writer to write? • Why was this title chosen? • How does the reading tie back to demonstrations or laboratories? • How does the reading connect to other discussions, readings, and lectures?
Shifts	**Analyze where the text changes** • Transitions: Where and why? • Read the first and last sentence • Why do you think the author began the text this way? Do they ask why the author ended the text in a certain way?
Summary statements	**Demonstrate understanding through analysis** • Write a summary statement that makes connections between the text and your knowledge and experiences.

The second S: Speaker (7 minutes)

The reason for examining the speaker is for students to explore the tone, opinions, biases, and unique points of view held by the article author(s). In addition, students can use the text to make inferences about the author's background and credibility. Students were very interested in the author named Jearl Walker. Although no credentials were provided in the text excerpt (see Figure 2), students believed the author was credible. For instance, one student wrote on the article, "I think the speaker seems like a trustworthy source because the facts seem to make sense." Another student wrote, "I think you can trust the speaker because the author seems to know a lot about physics." An internet search led students to learn that the author is indeed a credible source and has written for many physics textbooks.

FIGURE 2: The Five S strategy



The third S: Situation (5 minutes)

During the situation analysis, students investigate the main ideas presented in the text, the connections between the reading and topics covered in class, and relevance to everyday life. The main probing question used was "How does the reading tie back to demonstrations or laboratories?" Students connected the statement: "A steeper descent generates a greater acceleration, but packing the coaster with heavier passengers does not" with their firsthand experiences rolling cars of different masses and using steeper slope angles down an inclined plane (Walker 1983, p. 1).

The fourth S: Shifts (5 minutes)

The shifts analytical lens affords students the opportunity to examine the association among words within sentences and the organizational patterns across sentences to better understand the reading as a whole. When reading the beginning, students noticed that the introductory paragraph was intended to hook the reader's attention.

> … To me the scariest rides at the park are the roller coasters. The Big Dipper is similar to many

> of the roller coasters that have thrilled passengers for most of this century. The cars are pulled by chain to the top of the highest hill along the track. Released from the chain as the front car begins its descent (Walker 1983, p. 1).

Students also noticed a pattern in the layout of paragraphs, and some students identified paragraphs and portions within paragraphs as "hooks" (e.g., T1 and T2, where T was used as shorthand to indicate that a transition was used in the writing), which has the primary purpose of keeping the reader's attention. These students also identified other paragraphs' purposes as explaining science content (e.g., S1, S2, S3, and S4, where "S" indicated that the author was describing science content). For example, a student explained, "I noticed that it goes from a transition to science. They do it [referring to the author] to keep the reader interested and not bored with facts" (see Figure 2).

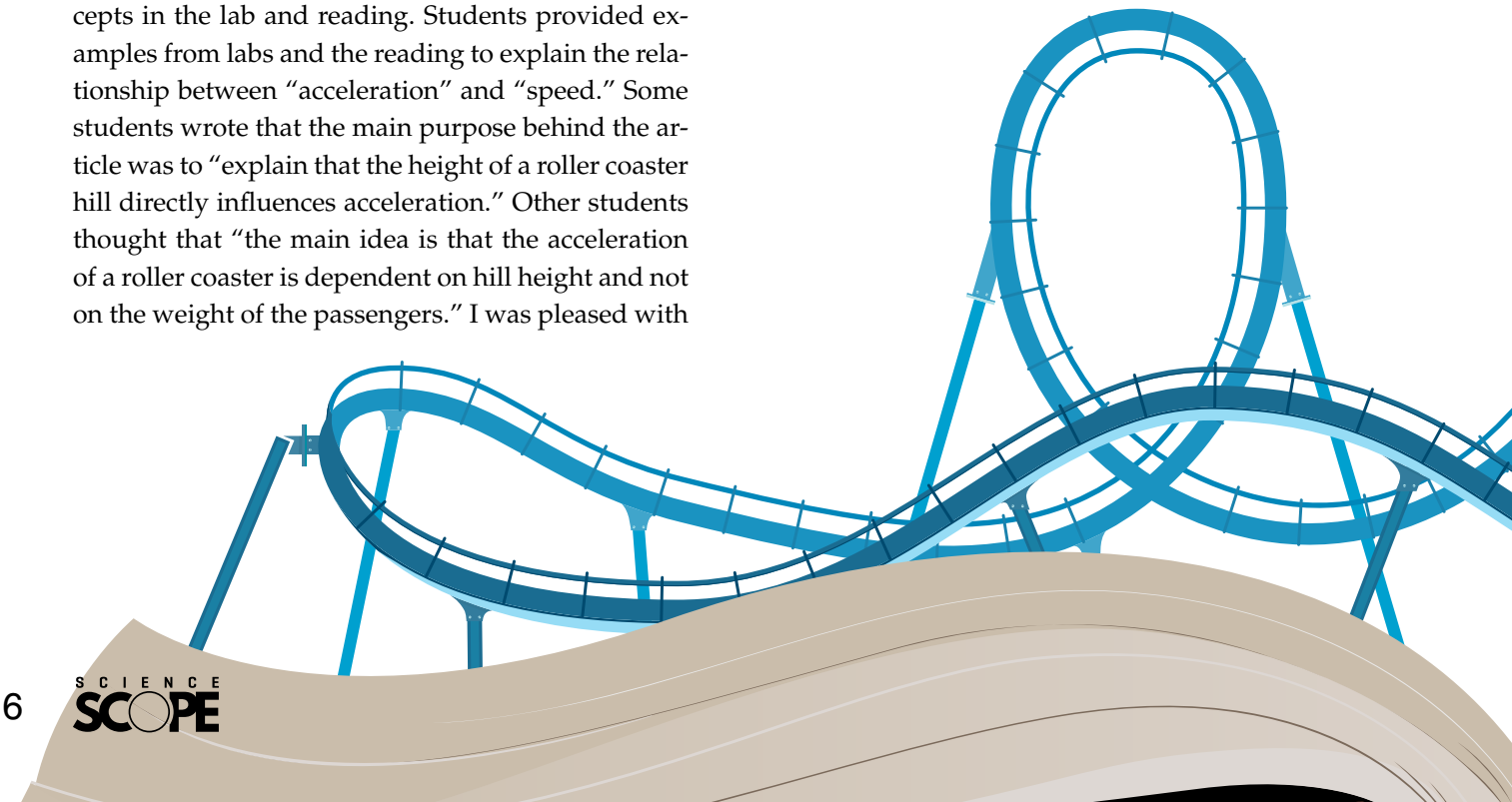
The fifth S: Summary statements (5 minutes)

Summary statements allow students to explain key vocabulary terms and make claims based on many sources of evidence (e.g., firsthand experiences with data and reading). Students wrote short summary statements to make connections between key concepts in the lab and reading. Students provided examples from labs and the reading to explain the relationship between "acceleration" and "speed." Some students wrote that the main purpose behind the article was to "explain that the height of a roller coaster hill directly influences acceleration." Other students thought that "the main idea is that the acceleration of a roller coaster is dependent on hill height and not on the weight of the passengers." I was pleased with student summary statements because students articulated what they observed during lab experiences and closely read in the article.

Lessons learned

The Five S strategy provided students with multiple unique perspectives to focus on when reading a text. The argument for implementing the Five S strategy is not that students should read all texts using all Five S lenses but that learners need strategies to reread texts to develop a deeper understanding. The benefit of having multiple S lenses to choose from is that teachers can vary the approach and maintain student engagement when using different texts.

Teachers will need to consider the nature of the content, the type of technical text investigated, and the learning goals (both content and literacy-oriented) when choosing particular lenses to use in harmony with other lenses. In this regard, I learned that it makes sense to use certain S lenses before other lenses. For example, it may better scaffold student learning to go from macro- to micro-level literacy analysis (e.g., Structure before Summary Statements). Many of the Five S lenses will be a new and different analytical perspective for students. The process begins by teaching students the purposes of the specific S analytical lenses and supplying learners with both general probing questions and text-dependent questions.



When using a particular lens, novice readers may need many text-dependent questions to guide their analysis. Novice students also might benefit from explicit questions about the structure, tone, transitions, and bias presented in a reading. Conversely, expert readers may be better able to read closely by reflecting and questioning what is known and unknown concerning a text. Expert readers may be able to efficiently choose the order and number of analytical lenses (e.g., specific S lenses) to achieve their goal.

As students become accustomed to the S lenses, they need teachers to model close reading strategies and be shown that the strategy is a beneficial way to promote analysis, synthesis, and evaluation of information. Shifting from novice to expert reader requires teachers to promote learners development of questioning and inferring strategies that will enable them to discover and deepen understanding of content presented in text. The rationale for developing more expert, self-sufficient readers is that students need a strong foundation in reading. Reading in science is important for comprehension and helps students develop strategies for deeper analysis of ideas and arguments. In addition, reading in science prepares students for information presented in texts and is a skill that is expected in college, postsecondary education, and the workplace. ●

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