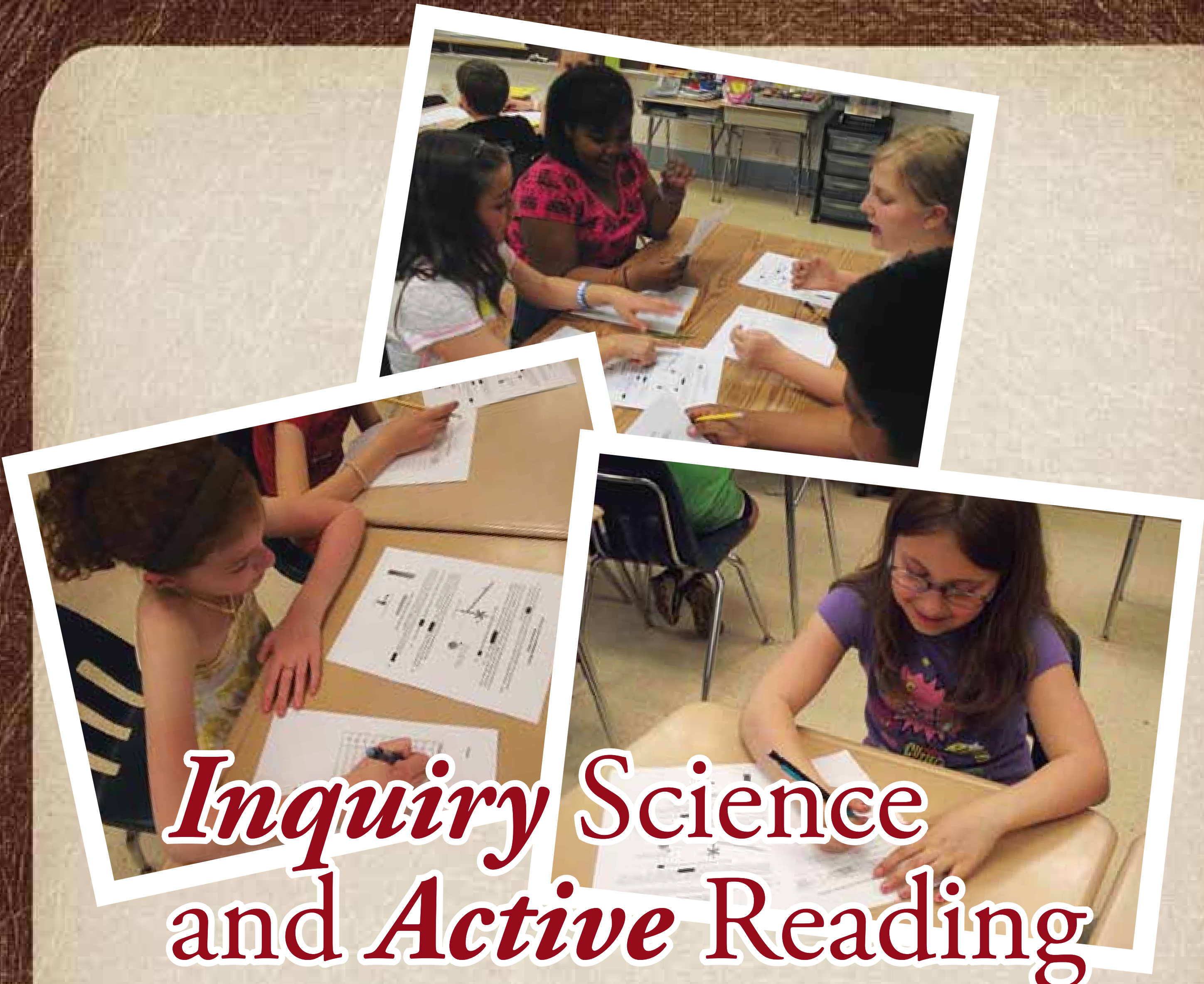

Inquiry Science and *Active* Reading

Pairing a force and motion lesson with a "blackout" reading activity

By Cody Sandifer

The pressure is on for elementary teachers to make interdisciplinary connections. For example, inquiry science activities can be coupled with conceptually relevant reading activities. Ideally, when this occurs, the reading activity maintains the same student-centered focus on ideas and reasoning established by the prior inquiry activity. Based on my years in helping practicing and preservice teachers implement inquiry lessons, however, my experience has been that inquiry activities are often followed by traditional question-and-answer reading exercises.

Pairing an inquiry lesson with a traditional reading activity creates a jarring philosophical mismatch between the interaction, deep thinking, and scientific reasoning that drives meaningful inquiry instruction and the "scan the text, copy the answers" response that we often obtain from our elementary nonfiction readers. Realizing that there must be a better approach, I recently made it my quest to seek and adapt reading activities that more closely match the spirit of science inquiry instruction.

Based on my search, I present a pair of fifth-grade activities: an inquiry science activity and an active reading activity. In the science activity, students use straws and marbles to conduct hands-on investigations of force and two-dimensional motion. In the reading activity that immediately follows, the students solidify their understanding of the inquiry lesson's underlying concepts as they collaboratively analyze a text that contains words that have been literally covered up (blacked out)—they've gone missing!

Inquiry Activity Overview

This inquiry on two-dimensional force and motion is divided into four sections: (1) Introduction (5 minutes), (2) Investigation #1: A Sideways Force (25 minutes), (3) Investigation #2: Crazy Shapes (30 minutes), and (4) Postassessment (10 minutes). The investigation handouts and postassessment (with sample answers) can be obtained online (see NSTA Connection).

The key science concepts are:

- When a rolling object experiences a brief force directly from the side, once the force is removed the object will continue to move in its original direction, and it will also now move in the direction of the brief push. This results in diagonal motion.
- Depending on the strength and angle of the force, a brief force can cause an object to change both its direction and speed.

The required materials for each student are one unbendable straw, goggles, a prediction handout, and a copy of the postassessment. The required materials for each pair of students are a single marble, the Sideways Force testing handout, and the Crazy Shapes testing handout. Goggles are needed for eye protection when students are working with straws. Students should not share straws, nor should they be allowed to blow air or other objects at each other.

CAUTION

Activity Introduction

The teacher begins the lesson by saying "Today's lesson focuses on different ways that quick pushes can change the speed or direction of an object," after which the class discusses examples of everyday forces that can cause objects to change their speed or direction. Common answers include the wind and a person pushing or pulling an object.

Next, the teacher introduces the inquiry questions:

- How does a rolling object move after receiving a quick push from the side?
- How can quick pushes from different directions change the motion of a rolling object?

Investigation #1: A Sideways Force

Students draw and present their predictions (with reasoning) for how a rolling object might move after receiving a quick push from the side (Figure 1). The teacher draws these possible paths on the board so that students can keep track of the different class ideas. A common prediction is that the marble will make a sharp 90° turn at the point where the marble receives the push.

To test their predictions, pairs of students receive a marble, two straws (one straw apiece), and the testing handout. One student gives the marble an initial motion that follows the straight line on the handout, and the other student uses the straw to blow a quick sideways puff of air when the marble reaches the indicated location. Students take turns blowing sideways on the moving marble and tracing the resultant paths on the handout until consistent results are obtained.

During the investigation, the teacher circulates through the classroom to ensure that students are following the proper testing procedures: (a) students are blowing on the marble directly from the side (rather than at an angle), (b) students are providing only a quick puff of air (rather than a continuous stream of air), and (c) the marble has sufficient initial speed that it achieves a clear diagonal motion after the push. If students have difficulty in getting the marble to initially move along the printed line, two rulers can be placed side by side (with a small space between them) to create a straight pathway for the marble.

Once the data has been collected, the class discusses how the actual path of the marble (a diagonal line) compares to the class predictions. In the discussion, students often express surprise that the marble moved diagonally, rather than making a 90° turn.

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Figure 1.

How does a marble move after the quick sideways push?

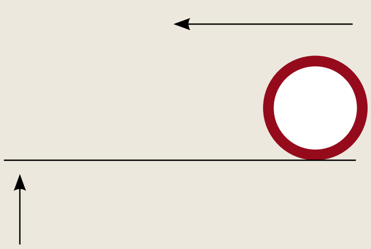
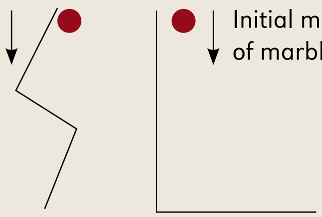


Figure 2.

Getting rolling marbles to follow paths of different shapes.



Investigation #2: Crazy Shapes

The teacher shows two "crazy" shapes on the board: a zigzag shape and an "L" shape (Figure 2) and explains that, for each shape, a marble has already started to roll, and a student would like to keep the marble rolling along the path as closely as possible.

For each shape, students predict how one or more brief pushes (in series, not acting together) might be used to keep the marble on the path. To make their predictions concrete, students draw arrows on the prediction sheet to show the location and direction of these different pushes. These predicted forces are then shared in a whole-class discussion, with the teacher drawing students' suggested force arrows on the board for everyone to see.

To test their predictions, as in the first activity, pairs of students use straws, a marble, and a testing handout (see NSTA Connection). For each shape, the students discuss and explore how to blow with their straws to keep the marble moving as closely along the path as possible.

Students are sure to get excited by the unexpected changes in the marble's motion (e.g., rapid changes in direction) that are caused by the puffs of air, so the teacher should help the students stay focused by carefully checking that only one brief force is being applied to the marble at any given moment (i.e., two forces are not applied simultaneously, nor is a continuous force being applied). Students who have difficulty getting the marble to make a 90° turn for the L shape might be guided to consider an angled force applied at the bend in the L. This suggestion is sometimes needed because, for the L shape, students instinctively blow on the moving marble at a right angle, which causes it to move diagonally (as established in the first investigation) rather than make a 90° turn. If any students have trouble controlling their marbles with puffs of air, table tennis balls can be substituted for the marbles in this portion of the lesson.

Once students have exhausted their exploration of the crazy shapes, the teacher holds a class discussion in which students use their experimental evidence to decide whether their predictions matched their results. Here, the teacher should point out that there might be more than one combination of forces (or perhaps a single force) that can be used to keep the marble moving in the desired manner. For example, for the L shape, multiple puffs of air can be used at different times to slow down, stop, and then shift the direction of the marble; a second solution is to apply a single strong force at just the proper angle when the marble reaches the corner of the L.

Finally, to cap off this fun hands-on experience, students deepen their understanding of two-dimensional motion and force by drawing a new and interesting shape of their choosing (e.g., a "V" shape) on a blank piece of paper to give to another group as a "challenge" path. The receiving pair attempts to use their straws to keep their marble moving as closely along the challenge path as possible. Before student pairs are permitted to give their challenge path to other students, however, they first have to demonstrate to the teacher that they know how to use their own straws to keep a marble moving along their own challenge path.

To further extend the lesson, individual students (or the class as a whole) might be encouraged to consider how to keep a marble moving along a curved shape, rather than a shape composed solely of straight lines.

Postassessment

To assess the students' conceptual understanding of the motion and force activity, students draw the path of a sideways-blown marble, show the locations and directions of three forces that can be applied to a marble to keep it moving along a particular path, and draw and explain the exact point at which a marble is likely to stray from a particular path.

Students work on their blackout reading handouts.

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"Blackout" Reading

Once the marble and straws inquiry lesson is complete, the last step is for the teacher to followup with a related 30-minute blackout "active reading" activity with the class. The blackout text passage, original text passage, and accompanying handout can be obtained online (see NSTA Connection).

A blackout reading activity is an activity in which certain words from a nonfiction text (which are numbered for easy reference) are covered up ("blacked out"), and then students individually and collaboratively try to determine what the words might be.

The blackout activity structure is an adaptation of the cloze procedure (Taylor 1953), which is a reading activity in which students fill in missing words in a paragraph. Key differences are that the blackout activity has significant collaborative elements, explicitly emphasizes reasoning, and highlights science content learning, whereas the cloze procedure is more generally focused on reading comprehension and often relies on word banks to scaffold students.

The handout that accompanies a blackout activity contains a three-column table. In column 1, students record their initial "best guesses" for the words. In column 2, following a group discussion, students record their updated "best guesses" for the words. In column 3, students record the actual identities of the words once the group discussions are complete.

The complete steps of a blackout activity are:

- The teacher obtains a prepared blackout text, or prepares a blackout text on his or her own.
- Copies of the blackout text and handout are distributed to the class, one per student.
- Students individually fill in their guesses for each word in the handout.
- Students discuss their guesses (and reasoning) with other members in their group, and then record their updated guesses in the handout.
- In a whole-class discussion, students share their best guesses (with reasoning) for the blackout words.
- Once the group discussions are complete, the teacher distributes the original unmarked text to the class and students record the actual blackout words in the handout.
- In a whole-class discussion, students share anything that they found to be interesting or surprising about the newly revealed blackout words. Students also discuss the ways in which they now have a better understanding of the science concepts and phenomena presented in the reading.
- Having gained an improved understanding of the text, students answer any written questions associated with the text, if any.

In this particular lesson, given the coupling of the inquiry and reading activities, the evidence and reasoning for the identities of the blackout words should come from two sources: (1) the experimental evidence from the marbles/straws activity that occurred immediately prior to the reading activity, and (2) contextual clues within the reading itself.

"Blackout" Teaching Tips

If a blackout reading spans multiple pages or if there is a wide variation in reading speeds in the classroom, one strategy is to break the blackout reading into paragraph- or page-size sections, each discussed individually. For example, for the two-page blackout reading that accompanies the 2–D lesson, the class might complete steps 3–5 for the first page, and then complete steps 3–5 for the second page. Then the class could move onto step 6: reading the entire original unmarked text.

Also, students should recognize that closely related words (e.g., *speed* and *velocity*) might be reasonable possibilities for a particular blacked-out word—and that determining the exact missing words isn't the most important goal. Different answers that "fit" conceptually should all be considered valid, depending on the goal of the lesson. The emphasis should be on reading to develop a better scientific understanding of the text, and not necessarily identifying all of the missing words correctly.

Why a "Blackout" Activity?

According to the Standards of the English Language Arts by the National Council of Teachers of English (1996), teachers should help students "apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts" (p. 3). However, in science, follow-up reading activities are often limited to a single variety of passive reading activity, in which students read a brief passage and then answer questions about that passage—typically by scanning the text and copying a few words into the appropriate blank answer space. In contrast, during a blackout reading activity, students actively infer meaning from the text, and in so doing naturally apply such critical reading strategies as reading words carefully, rereading, using contextual clues in neighboring sentences, and looking at pictures and other text objects.

Student motivation and excitement during a blackout activity also runs high as students—even those normally reluctant to participate—engage in animated discussion about the possible identity of the covered words, their connections to the prior experiments, and the greater context and conceptual meaning of the reading. Toward the activity's conclusion, the students eagerly look forward to checking the original unmarked text to determine whether their educated guesses are correct.

One final reason why blackout activities are attractive to teachers is that the preparation time to create a new blackout activity is minimal. The teacher need only photocopy a few pages from the original text, black out and number particular words from the photocopied passage, and then make one copy of the blackout passage and accompanying three-column handout for each student. In terms of which words to cover up, blackout words are purposefully selected such that they are tied directly to the lesson's key concepts and inquiry questions.

An Ideal Combination

Presented here is a combined hands-on science and active reading lesson related to two-dimensional force and motion. As philosophical complements, both the reading and inquiry science activities share the goal of having students draw their own conclusions based on evidence-based reasoning. In so doing, they also successfully manage to support questioning, provoke curiosity, and maintain student interest in the material. For me, this pairing of inquiry science with active nonfiction reading is an ideal method for captivating and expanding the minds of our students in a student-centered manner that is not often seen in today's classrooms.

Having tried a blackout activity once, your students will no longer only associate the word *blackout* with sitting idly in the dark with flashlights and candles, waiting for the power to return. Instead, *blackout* will now also be associated with fun opportunities to discuss scientific concepts and evidence—just as it should be! ■

Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry (K–8)

Standard B: Physical Science

- Motions and forces (5–8)

Program Standards

Standard B:

The program of study in science should connect to other school subjects.

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academies Press.

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NSTA Connection

Download investigation handouts and postassessment at *www.nsta.org/SC1110.*