Science and Literacy Centers

This win–win combination enhances skills in both areas.

By Beth Dykstra Van Meeteren and Lawrence T. Escalada

In recent years, science has taken a backseat to reading and mathematics in many primary classrooms. Imaginative teachers have coped with this loss of science time by creatively integrating science topics into reading instructional materials (Douglas, Klentschy, and Worth 2006). There are many resources that address life science topics, but fewer that address the physical sciences. I know students are interested in the biological life of the world around them, but they are no less interested in physical science (i.e., how the world of everyday objects works). When I watch students at recess, I see them exploring ramps as they play on the slides, investigating the force of air by opening and holding out their jackets, and testing ways to change how fast a pinwheel spins in the wind. I've discovered how to capitalize on students' natural curiosity about how things work and highlight the connections between inquiry science and literacy skills by adding a hands-on science-learning center to the guided reading and literacy centers in my first- and second-grade classroom. In this article, I describe an effective physical science center that I incorporate as part of my reading instruction—the inclined plane center. I've found that the skills and confidence students gain at this center transfer to the guided reading and literacy centers, leading to gains in both science and literacy. Using this combination of science and literacy centers has proven an excellent method for addressing physical science explorations in the primary classroom in a manageable way.

Inclined Plane Center

Guided reading requires the teacher to work with small groups of students who have similar reading processes and can read about the same level (Fountas and Pinnell 1996), leaving the rest of the students to work independently. Literacy researchers advocate building an infrastructure of centers that maximize literacy learning away from the teacher. Suggested centers include such staples as listening posts, writing centers, pocket charts, partner reads, and ABC games (Ford and Opitz 2002; Owocki 2005). Other suggestions include pretend play centers, which offer children a context for critical reflection as they role play, often as scientists (Owocki 2001). Adding a physical science center to the existing literacy centers, however, allows students to do more than role play as scientists. As students manipulate the materials at the science center, they are doing science, asking questions, and developing inquiry skills.

To set up my inclined plane center, I collect various objects that roll, such as marbles, steel ball bearings of different sizes, and various types of balls. I also collect objects that slide, wobble, spin, or do not move at all on an incline, such as Legos, clothespins, wooden wheels, feathers, cotton balls, small cars, plastic eggs, stones, cubes, and paper clips. The varied selection encourages students to think hard about the properties of the objects and how those properties affect movement.

For tracks, I use wooden cove molding purchased from a local lumberyard or home-building supply store. It is cheap, durable, available nationwide, and a good size for children to handle. (For approximately $40, you can buy enough lengths of cove molding to make a set for the classroom; have an employee cut the molding into one-, two-, three-, and four-foot lengths.) Make sure the molding is sanded to prevent splinters. To support the tracks, unit blocks work best and encourage mathematical reasoning (Chalufour et al. 2004). Fifty blocks is enough for a good start.

CAUTION

Establishing the Stage

Typically, I introduce the inclined plane center to the students at a class meeting. Rather than providing explicit directions as I do for my literacy centers, I hold a section of track and a marble and simply say: "I brought some materials you may be interested in working with. If I put this marble right in the middle of the track, is there any way I could get it to go off the end without touching it?" The students' initial ideas are often blowing on the marble, pushing it with another object, or wiggling the track to move the marble off. As we discuss and experiment with the marble and track, students begin to notice that tipping one end up enables the marble to roll to the opposite end. I invite students to visit the center by saying: "You have a lot of ideas. Let's go set up the center so you can begin investigating those ideas."

Keeping the center open-ended with the goal of developing the abilities necessary to do scientific inquiry allows students to explore a design challenge they set for themselves. In addition, constructing ramp systems provides rich opportunities to address *National Science Education Standards*. As children plan and conduct simple investigations into why their system is able or unable to work, not only are they developing the ability to problem solve, but as they do so, they are also developing understandings about physical science and about the properties of objects and materials and the position and motion of objects.

Students are usually eager to begin, so we start by making decisions together on the organization of materials and space at the center, and we post a set of student-developed rules there. This is an excellent opportunity for authentic writing that engages every student. Together, we brainstorm ways to keep the ramp center an inviting, respectful, and safe place to work. Typically, students suggest such rules as "keep your marbles in your space so no one slips on them." We also discuss that carrying tracks vertically is the safest method because carrying track horizontally can harm other people and/or materials.

PHOTOGRAPH COURTESY OF THE AUTHORS

Two children work at building a "switchback" system in which the marble drops down to the next level and travels in the opposite direction.

When children are cocreators of rules, they are more willing to follow them and hold themselves and each other accountable (Devries and Zan 1994).

At the Center

Once the ramp center is up and running, I observe students at work between guided reading groups. During these observations, I support the children's experimentation and encourage reasoning. This support is done through thinking aloud, questioning, and sometimes modeling (Figure 1, p. 83)—the same techniques I use in literacy instruction for reading strategies (before, during, and after). To encourage reasoning about causal relationships, I often limit variables by adding or taking away materials. In the beginning, I give students one size of track, one unit block, and one type of marble. Students can vary the steepness of the incline in only three ways depending on how they place the unit block (flat, on end widthwise, or on end lengthwise), allowing students to observe relationships between:

- the high end of the ramp and the direction of the marble;
- the height of the ramp and how fast the marble rolls;
- the spot where the marble is released on the ramp; and
- the distance traveled by the marble off the ramp.

Later, I take away the marbles and add a bucket of different items (e.g., odd-shaped stones, plastic eggs, paper clips) to test down the ramp, and later again, I have them test different lengths of track. (Rolling a marble down a 4-foot length of track propped up on one block is a lot


PHOTOGRAPH COURTESY OF THE AUTHOR

Two children work on a system involving a ramp balanced on a fulcrum on which the weight of the marble causes the track to tip and place the marble on the next track. Another child works nearby focused on a different question.

different than rolling a marble down a 1-foot length!) Through these various explorations, students investigate how objects can move without being touched, how the shape of an object affects its relative motion down a ramp, and how the steepness of the incline determines how fast the object moves and how far it will travel.

My daily guided-reading time is structured so students move from guided-reading groups which last from 20–30 minutes to a block of 60–90 minutes that is spent in the active physical science centers and then more traditional literacy centers. Because membership in the guided reading groups varies according to specific literacy needs, students have the opportunity to collaborate with all of their peers.

As I dismiss one group of students from guided reading, they update me on what they are investigating in the ramp center. It is amazing to hear students' comments about working out bugs in their system designs, such as: "The ramp is too steep and the marble is going too fast" or "The first ramp isn't steep enough to give the marble enough speed to make it up the next hill." As I check in with each student, I record anecdotal notes on their progress (e.g., on their independence in posing their own problems to solve, their ability to address those problems independently or collaboratively, their discoveries about design and physics, and their collaboration with peers). I also take photos of completed structures so students can revisit their work and not feel badly about taking their hard work apart. Then, I encourage the students to draw their ramp center work to a close and head to the literacy centers, leaving room for the new group of investigators.

Sharing Knowledge

In class meetings, usually preceding a writing workshop, students share with the whole class what they are learning at the ramp center. I encourage conversation and support them to provide clear explanations to extend their vocabulary and concept development. For example, when students are sharing their successes in getting spheres to turn corners, they talk about how the properties of the spheres affect success:

"The ball bearings are smaller than the shooter marbles, but they are heavier. They are made out of steel. Steel must be heavier than glass."

"I think the regular marbles work best. They're made out of glass like the shooter marbles, but they aren't as heavy because they are smaller and there is less glass."

"I don't think how big it is matters as much as how heavy it is. I'm going to try a Ping Pong ball. It's about as big as a shooter marble, but it's made out of plastic and it's not solid."

As we discuss students' observations, I record their ideas of how things work and introduce the term *hypothesis* in our discussion. "So your idea, or hypothesis, is that the Ping Pong ball will work better than the shooter marble because it is lighter. How could we find out if that is true?" These discussions often inspire students to try classmates' ideas or test new ideas generated in the discussion. Vocabulary such as *hollow, solid, ricochet, angle, weight,* and *force* become necessary to learn as students try to convince each other in their thinking. Inspired by their work at the ramp center, many students spontaneously write about their discoveries at the writing center and bring these documents to class discussion.

Sometimes I photograph details of ramp systems to draw students' attention to specific attributes contributing to the marble's movement, such as the careful positioning of one block buttressing another to ensure it doesn't move when the marble strikes it. After printing the photos, the builder/builders of the ramp system examine them and I question them. "I notice you have another block here behind this one. I'm wondering why you needed to do that." This encourages deep thinking as students consider how the constraints of physics influence their engineering or design. "The marble hits the first block so hard it moves it, and the marble doesn't go on the next track. This other block helps hold it so it doesn't move and the marble ricochets onto the next track." In this way, students begin to build their understanding of such things as force and motion.

Figure 1.

Teacher talk to support inquiry.

I wonder how far the marble will roll off the end of that ramp.

I notice the marble is stopping here. Is there a way we can get the marble to roll farther?

What do you want to happen?

I wonder why the marble won't go further.

You seem frustrated with this part of your structure falling. Would you like some help in building this section so it doesn't keep falling down?

I wonder if you can help me build a ramp system that can make the marble change directions. What do you think I need to do first?

Look closely at this corner and tell me what is happening to the marble.

Why It Works

Not everyone can envision physical science and literacy centers working together. Some teachers may feel that physical science and literacy are incompatible; others may not feel confident in their physical science knowledge, so they are reluctant to try this type of center. A closer look at parallels in inquiry in science and inquiry in literacy may prove convincing.

First, science inquiry and reading comprehension strategies share the same cognitive functions. Both facilitate activating prior knowledge, establishing purpose/goals, making/reviewing predictions, drawing inferences and conclusions, and making connections/recognizing relationships (Cervetti et al. 2006).

Second, the process of developing skills in inquiry and problem-solving at the ramp center empowers students as learners, and these problem-solving skills transfer to the literacy centers. When things do not go as planned at a ramp center investigation, I've observed that students do not view this as an unnatural or negative experience. Students think hard about what they already know and use many disciplines to solve the problem—they adjust an angle of a block, the pitch or height of a track, or a gap between two pieces. They enlist the help of peers, asking them to start the marble so they can observe the problem area more closely. They present their difficulty to the class and ask their peers for advice. They persevere, working diligently until they coordinate each component of the system to make it work, or decide the system is impossible with the materials they have and change the design. This integrative way of thinking spills over into many domains: literacy, science, mathematics, and even social development.

In reading, having become comfortable trying many times at the ramp center, I've observed that students aren't as concerned about reading or spelling a word incorrectly—they know that mistakes are just opportunities to learn so they are willing to try again. Similarly, in math, students who were previously timid about solving number problems often begin to enjoy analyzing them, taking great pride in demonstrating different ways to arrive at the correct answer.

Final Thoughts

It isn't necessary to know everything about force and motion to facilitate students' understanding at a physical science learning center. Although it is necessary for teachers to understand the components they expect students to develop through their work at each center (How can you dispel student misconceptions otherwise?), the most important factor is providing opportunities for concrete experiences that, in the future, will allow students to connect to more abstract concepts. As students work with the ramps and materials at the center, not only are they developing inquiry skills but they are also exploring the basic laws of physics in an age-appropriate way. By incorporating physical science into the primary classroom, you have both broadened students' experience of science and put physical science back on the education bus, making for a more exciting and interesting ride. ■

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Connecting to the Standards

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

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry

Standard B: Physical Science

- Properties of objects and materials
- Position and motion of objects

Standard E: Science and Technology

- Abilities of technological design

Teaching Standards

Standard D:

Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.

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