Comprehension Strategy Instruction for Multimodal Texts in Science

This article highlights examples from a middle-school science teacher’s instruction using multimodal texts. Its importance lies in reconciling narrowed definitions of reading (and hence reading instruction) with the need to develop students’ critical awareness as they engage with multiple sign systems, or semiotic resources, used for constructing meaning. After a brief introduction to the multimodal nature of scientific texts, the authors ground their discussion of comprehension strategy instruction in a vignette that shows the students and their teacher examining their school’s attempt to prevent further soil erosion on the campus grounds. The article also provides examples of how multimodal text instruction in science can lead to making connections to other texts, such as the photographs and maps of America’s Dustbowl in the 1930s. Although not without its limitations, comprehension strategy instruction for multimodal texts offers students choices in how they will represent content that matters to them.

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ON A BRIGHT AFTERNOON, an earth science teacher and her students walked across their hilly middle-school campus to learn about erosion. Located in the southeastern United States, this school received over 50 inches of rain per year, and several failed attempts had been made to prevent its soil from washing away.

“If you look right here,” Ms. Thompson (pseudonym) said as she pointed to a patch of
land without grass, “You can see where some of our soil has washed away. This used to be a whole lot worse. Last summer they did a whole lot of stuff around the school. They came in and planted some grass seed. What do you think happened to that grass seed?”

“It got washed away,” responded one student.

“Right, it got washed away; it got eroded away. And you can see what else they put on it to try to prevent the erosion. What else do they have here that shows they tried to prevent the erosion of the soil?”

“Little sticks.”

“Yeah, little sticks. It’s called mulch. Where did a lot of that end up?”

“Over there by the drain,” another student responded, pointing to another spot on campus.

“Over there by the drain. It all got washed that way. I want you to come and see where the erosion has taken place. Let’s head over here.”

The students trekked to another location on campus, where the teacher asked them to look at a pile of rocks along the boundary of the school’s property. (See Figure 1.) “All right, what do you see?” she asked.

“Rocks.”

“Why are there a bunch of rocks here? Because they did not originate or start here. Why do you think there’s a bunch of rocks right here?”

“To keep the water from flowing,” replied one student, and another rejoined, “When it rains and when the water comes, so that water can flow but not the dirt.”

The students and Ms. Thompson continued to analyze the land near the pile of rocks, wondering why the nearby trees had been cut down and evaluating whether this action would have accelerated or prevented erosion of the landscape. Students then returned to their classroom, discussed other examples of efforts to prevent erosion that they had seen in their own
neighborhoods, and compared pictures and maps of the American Dustbowl to what they had just observed.

The Multimodal Nature of Scientific Texts

As this example illustrates, science teachers and students may draw from multiple semiotic resources to understand and communicate scientific content (Kress, Jewitt, Ogborn, & Tsatsarelis, 2001; Lemke, 1990). In various branches of science, this content is often related to the study of different aspects of the physical universe (Bazerman, 1988), such as animal or plant life, human body systems, laws of motion, atoms, celestial bodies, DNA, and more. Because science addresses different aspects of the physical universe, the observable properties and spatial arrangement of different entities are often essential for understandings of scientific content. Therefore, scientific disciplines may be particularly dependent on a variety of visual displays or objects, such as models, diagrams, photographs, videos, and other iconic representations that bear a physical resemblance to the items they represent (Pauwels, 2006; Peirce, 1991). Moreover, students’ primary texts may be the physical world itself as they read landscapes, internal organs, lunar phases, or cells underneath a microscope.

Given the nature of diverse semiotic resources used to convey and construct meaning in science, theories of multimodality (e.g., Jewitt, 2008; Kress & van Leeuwen, 2001) are appropriate for conceptualizing literacy instruction in this discipline. According to these theories, multiple modes, or semiotic resources used for constructing meaning, are valid and fully articulated forms of communication in their own right. Different modes—such as images, gestures, written language, spoken language, and three-dimensional models—each have their own affordances, or potential uses to which they lend themselves (Gibson, 1979; van Leeuwen, 2005). For instance, photographs may afford the visualization of spatial relationships more fully than written or spoken words because photographs simultaneously display multiple objects in a given space (Kress, 2003). Theorists of multimodality, therefore, insist that written and spoken language should be understood as but two modes among many legitimate modes that can be integrated and used to convey meaning.

Science teachers, such as the one described in the opening vignette, have long used different representations to explain scientific content to students. For instance, Rosenthal and Bybee (1987) described teachers from the early 1900s who required their students to use measuring or magnifying instruments to read aspects of the physical world, a practice that is still common in science classrooms today (Siskin, 1994). Yet with the exception of a literature that had its roots in research on emergent literacy and a move away from verbocentrism toward multiple sign systems (Siegel, 2006; Teale & Sulzby, 1986), little else has changed in the literature that presently informs comprehension instruction in the content areas (Heller & Greenleaf, 2007; Lee & Spratley, 2010). It is still largely print-centric and tied to explicit strategy instruction in linguistic-bound texts.

Although this type of instruction is vital, given that written language remains a primary mode through which scientists convey meaning, it tends to overlook an equally viable approach to comprehension through transmediation—that is, the “translation of content from one sign system into another” (Suhor, 1984, p. 250). As Siegel (2006) explained, learners who move across two or more sign systems (e.g., images, written words, gestures) have opportunities to invent connections between them, which can lead to richer and more complex understandings. Traditionally, comprehension has been defined as “the reconstruction of the intended meaning of a communication” where “the presumption … is that meaning resides in the message awaiting interpretation, and that the message received is congruent with the message sent” (Harris & Hodges, 1995, pp. 38–39). Like Siegel and others, we view the reader as having agency in the process of comprehending, and the message as having meaning despite the mode in which it is encoded.
Conceptualized this way, comprehension is not different from understanding. We suggest that, by conceptualizing comprehension instruction in science classrooms from a perspective of multimodality, researchers and teachers can account for linguistic texts along with other texts comprised of multiple modes. When conceptions of comprehension strategy instruction are expanded to address multimodal texts, students can be more fully supported in strategically approaching the reading of many forms of texts that are central to understanding scientific content (Prain & Waldrip, 2006).

**Comprehension Strategy Instruction for Multimodal Science Texts**

How might explicit comprehension strategy instruction be applied to multimodal texts in science? We return to the opening vignette to speculate on possible answers to this question. Ms. Thompson required students to use many of the comprehension strategies that are applicable to the reading of linguistic texts (e.g., Block & Pressley, 2002) as she helped them to make sense of erosion on campus. We outline several of these comprehension strategies below.

**Making Connections Across Texts**

Ms. Thompson’s students made connections among the pile of rocks, the mulch, and the grass seed as they identified that all three of them were designed to prevent erosion on campus. Students then connected the erosion that they read on the landscape of their campus to the maps and photographs of the Dustbowl in America in the 1930s, and they connected all of these texts to their own experiences by identifying how people tried to prevent erosion in their own neighborhoods. By engaging her students in the generative process of transmediation, Ms. Thompson provided opportunities for them to make connections across multimodal texts in ways that led to complex understandings about erosion in multiple contexts.

**Making Inferences**

As students were reading the landscape, Ms. Thompson required them to use their background knowledge and the features of the campus to make inferences about erosion. For instance, she asked them to infer what had happened to the grass seed, to infer why people had placed rocks in the gully, and to infer whether the removal of the trees beyond the fence had accelerated or prevented further erosion.

**Setting a Purpose for Reading**

Ms. Thompson set a purpose for her students’ reading of the landscape at the beginning of the lesson when she stated, “We are going on an on-campus field trip today. We’re going to walk around campus and look for examples of erosion that have occurred.”

**Distinguishing Salient From Nonessential Information**

Ms. Thompson drew attention to features of the landscape that were salient to understanding erosion on campus, rather than focusing on features that were relatively unimportant. For instance, the chainlink fence (see Figure 1) was placed on campus to indicate boundaries between properties, rather than to prevent erosion. Although it, perhaps, served as a marker of the amount of erosion that had occurred, it was not important to understanding the school’s efforts to prevent erosion. Accordingly, Ms. Thompson drew her students’ attention to the rocks, rather than to the fence, as the salient feature of the landscape in terms of her lesson on the prevention of erosion.

Along with implicitly requiring the use of these comprehension strategies, one could easily imagine other strategies that Ms. Thompson could have applied. For instance, she could have asked students to predict what would happen to parts of the landscape after the next heavy rainfall, and then students could return outside and check their predictions. She could encourage them to monitor their comprehension of the
erosion on campus by attending to features of the landscape that puzzled them and then use the strategy of asking questions about what they did not understand (Alvermann, 2004). Students could draw and label a picture of what they envisioned the campus would look like 10 years from now—an activity that would require both prediction and visualization of future possibilities. Used in these ways, comprehension strategy instruction for learning with multimodal texts shares much in common with strategy instruction for print-centric, linguistic texts. It also contributes to teaching for critical awareness, or the explicit questioning of how texts “position people in certain ways and serve some interests but not others” (Lewison & Leland, 2002, p. 108).

**Comprehension Strategy Instruction Takes a Critical Turn**

Often the reading process, whether in science or in other content areas, is assumed to consist of “an active reader who constructs meaning through the integration of existing and new knowledge and the flexible use of strategies to foster, monitor, regulate, and maintain comprehension” (Dole, Duffy, Roehler, & Pearson, 1991, p. 242). Research in the 1970s through the mid-1980s tended to support such a view, particularly with its emphasis on metacognitive strategy instruction (Rosenshine & Meister, 1994). However, by the late 1980s and 1990s, an interdisciplinary group of scholars (e.g., Bloome & Green, 1992; Gee, 1996; Luke, 1988; Street, 1995) started to ask questions such as “What is reading?” “Who benefits from being literate?” and “What specific cultural meanings and social practices are bound up in both multimodal and linguistic texts?” The impetus for asking these questions, all of which point to the different contexts in which students make meaning of all kinds of texts, was a growing mistrust of the dominant view of literacy as a neutral or technical skill largely explained by individual variations in cognitive and physiological functioning.

This mistrust, cast in a positive light, is at the very root of what it means to be critically aware as a reader, writer, viewer, or listener. If Ms. Thompson were to push for critical awareness among her students, she might ask them to question certain assumptions about the erosion on their school campus. For instance, what led to the deterioration of the campus grounds? Who noticed its decline? Who did not, and why? Were there benefits and/or disadvantages to be gained from removing trees in the area? For whom were there benefits and for whom were there disadvantages? Why did someone decide it was time to plant grass seeds on campus? Who held the authority to make that decision, and what stakeholders were consulted (or not consulted) as part of the decision-making process? How did the eroded campus compare to public places in their own neighborhoods? Would they expect to see such erosion on the White House lawn in Washington, D.C.? Why or why not? Answers to these questions could be obtained through examining old photographs of the school campus, interviewing people who lived in the area when the school was built or remodeled, interviewing the school board members or others who made decisions regarding the upkeep of campus and the surrounding areas, taking virtual tours of the White House lawn on the Web, locating newspaper clippings or televised footage of the removal of the trees, and taking digital photos in their own neighborhoods.

Put another way, if Ms. Thompson wanted the students in her earth science class to develop a critical awareness of how their eroded campus compared to conditions in the American Dustbowl, she would need to involve them in activities that demonstrate how interpretations of multimodal texts are “part and parcel of, and inextricable from, specific social, cultural, institutional, and political practices” (Gee, 1999, p. 356). Weaving in a critical approach to her science teaching would entail lessons that show how reading objects (e.g., the rocks), physical sites (e.g., the eroded school campus), and neighborhood values (e.g., caring, or not caring, about soil erosion) entail taking into consideration how each of these texts relates to the larger milieu in which it is situated. Although Ms. Thompson’s science textbook did not mention critical
awareness instruction, her inclination was to engage students in comprehension instruction that aligned with a different way of conceptualizing what counts as science literacy. She enabled her students to grow in their awareness that mining print-based texts for their literal or inferential meanings, although important, is an inefficient strategy for understanding multimodal texts that constantly surround them.

**Choices Students Make in Representing Content That Matters (to Them)**

The research on adolescents’ online digital literacies is rife with evidence that young people think a lot about multimodal texts and make choices about the forms of representation they believe will produce content that is meaningful to them and has exchange value in virtual communities built around shared interests (Alvermann, 2008). That most of this research comes from studies conducted in out-of-school contexts need not distract from the importance of the findings, for as noted in a report released by the PEW Internet & American Life Project (Lenhart, Madden, Macgill, & Smith, 2007), blogging, working on a Web page for school or for personal use, sharing original content (e.g., artwork, photos, stories, or videos), and remixing online content to create new texts involve multimodal literacies that are central to the lives of 21st-century youth.

Science educators, especially those who are aware of the research on comprehension strategy instruction using multiple symbol systems, acknowledge that the nature of scientific texts calls for a different pedagogy in teaching students to interpret those texts. For example, Prain (2009) cited a number of findings from research in science teacher education that argue for “more causal, mechanism-driven studies that identify the changing demands students face in constructing and interpreting multimodal science texts as part of learning science literacy . . . and pedagogical processes that enhance and maximize this learning” (p. 161).

Literacy researchers (e.g., Rogers, Winters, LaMonde, & Perry, 2010) whose work lies outside the traditional bounds of science education have identified relevant elements of multimodal text production (in this instance, video production) that can make critical meaning makers out of disengaged, and sometimes marginalized, youth. Applied to science education, these elements of production include critical expressions (using still images and videos), audiencing (getting one’s point across), and positioning (juxtaposing contradictory views). All are essential for teaching a critical approach to multimodal texts. For instance, critical expressions in Ms. Thompson’s class might include students’ visual representations of the school campus before and after soil erosion had occurred—perhaps accompanied by a cartoon that addresses issues of social and cultural pressures leading to, or resulting from, the deterioration of the landscape. Using the same example, we could picture students taking into consideration the audience for whom their visual representations and cartoon were intended. The imagined reception of these critical expressions could be compared and contrasted to the audience’s actual reception, possibly through interviews with people in the community, members of the school board, and others in the intended audience. Juxtaposing contradictory evidence obtained through the interviews might expose the sociocultural, institutional, and political narratives that prompted certain individuals to position themselves as they did on the issue of campus erosion.

**The Limits of Representations**

Although teachers may use similar types of comprehension strategy instruction for both linguistic and multimodal texts, we contend that the comprehension of multimodal texts may encompass additional instruction as well. Specifically, as students develop a meta-knowledge about multiple forms of texts, they can be taught to evaluate the affordances and constraints of different modes.

Just as each form of representation may enable the understanding of scientific content based on its distinctive affordances, it may also constrain
students’ understanding of that same content by what it cannot represent. For instance, one affordance of the landscape was that it enabled students to envision simultaneous spatial and physical relationships between the hills, the gullies, the rocks, the mulch, the trees, and the grass seed as they speculated on the connections between them. However, one constraint of this text is that, although it provided a snapshot of the placement of these land features, it did not provide an account of these features over time. Moving images such as videos, in contrast, do afford the visualization of changing spatial relationships over time. One could imagine video footage of the campus throughout the last 10 years, fast-forwarded to highlight key instances of erosion and attempts to prevent it, with a video clip of the ground in a thunderstorm when the grass seed was being washed away.

As another example of affordances and constraints, we turn to Ms. Thompson’s lessons on the phases of the moon. The constantly changing spatial relationship between the earth, moon, and sun is central to understanding the causes of lunar phases. Although students viewed photographs of the moon taken at different points throughout the month, this representation was limited in its ability to represent how the earth aligned with the moon and the sun. To provide students with a representation of this alignment, Ms. Thompson used several diagrams to show how the spatial placement of the celestial bodies affected what students observed from earth. Students placed photographs of the moon on various places of the diagram to indicate what they would see from the earth when the three celestial bodies were aligned in different ways.

This type of representation was still limited in its ability to show how the celestial bodies were constantly revolving in relation to one another. To counter these limitations, Ms. Thompson and her students participated in various demonstrations, such as rotating and revolving in a darkened room where students could see the light from the sun (a light bulb) produce shadows on the moon (Styrofoam balls held by each student) as their heads represented the earth. This type of representation was limited, too—for instance, by its inaccurate scale. Understanding the affordances and constraints of multiple representations, Ms. Thompson combined several of them to offset the limitations of each individual text.

These examples illustrate that scientific representations can both reveal aspects of the physical universe at the same time that they conceal or even distort other aspects of it (Pauwels, 2006). Because every representation is only a partial reflection of phenomena (Freebody, Luke, & Gilbert, 1991), students can be taught to interrogate representations through reflecting on what the form of representation allows them to see as well as what it prevents them from seeing. This approach to multimodal texts would not only support students’ critical readings and interrogations of texts, but it would also help them to design scientific texts of their own as they thought about what forms of representation would most fully enable them to express the content they wish to convey (Wilson, 2008). This approach to multimodal texts would also enable students to engage in transmediation themselves by representing the same content through multiple modes as they considered how the affordances of some representations can complement and counterbalance the limitations of others.

**Looking Back to See Ahead**

Ms. Thompson implicitly required her students to apply various comprehension strategies in their reading of the landscape, as they read with a purpose, made inferences and connections, and distinguished important from nonessential features of the land. An underlying principle of comprehension strategy instruction, however, is fostering students’ metacognition, or the active monitoring and regulation of their thinking processes as they approach texts (Yore & Treagust, 2006). As we envision future possibilities for comprehension strategy instruction in science classrooms, we can imagine science teachers who encourage students to apply similar strategies to their reading of multimodal texts. In addition, these teachers would support stu-
dents in becoming aware of how they could independently apply comprehension strategies to other multimodal texts. Teachers can encourage students to develop this awareness by using explicit terminology related to the strategies, by modeling the strategies, and by asking students to reflect on their effectiveness after applying them to their readings of multimodal texts.

Comprehension instruction on multimodal texts, however, can extend beyond the scope of the science classroom. Students can be taught to monitor their comprehension as they read manipulatives in mathematics and connect these readings to numeric equations, drawings, and word problems. In social studies, they can critically interrogate and compare music, photographs, videos, and monuments by asking how the perspectives of the text designer informed the creation of the text, and how another designer with different group affiliations or from a different time period might have created the text differently. In physical education, they can learn how to “read” football fields through explicit instruction on its unique text features.

As we envision future possibilities for comprehension strategy instruction, we believe they will be grounded in expanded notions of texts that include gestures, images, models, numbers, the natural world, words, and myriad combinations of these and other modes. We envision comprehension instruction that legitimizes and accounts for these texts as indispensable means of communication that work in tandem with each other, and we imagine that this comprehension strategy instruction will address systematic and explicit ways for supporting students as they construct meanings across these texts.

In science, a content area that relies on a variety of visual displays and linguistic texts, this type of multimodal instruction is especially crucial. We envision science teachers who encourage students to develop a critical awareness in their readings, while at the same time supporting them to produce their own multimodal content that is rich in creative, critical, purposeful expressions. That is the scientific process and one worth enacting multimodally, in our view.

References


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