Cross-Curricular Literacy: Writing for Learning in a Science Program

The Voice of Shelley, a Teacher Educator and Researcher

When I walk through the science wings of middle schools, I do not often hear boisterous conversations about writing, about how it enriches student learning and nurtures their creativity. To be fair, I do not hear talk of simple machines while walking down the halls of the English wings, either. That is not the case, however, in one middle school in a Canadian province where Leonora, an eighth-grade science teacher, works. She believes in the importance of writing in learning science. Unlike many of the books on genre writing that are written from an English language arts teacher’s perspective (Allen, 2001; Harvey, 2002; Romano, 2000), this paper is written from her perspective as a science teacher.

Voice of Leonora, an Eighth-grade Science Teacher

Theoretical Frameworks

As a science teacher, I strive to help my students become “scientifically literate,” which for me is best encompassed by the Association for the Advancement of Science (1989) definition:

a scientifically literate person is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of sciences; is familiar with the natural world and recognizes both its diversity and unity; and uses scientific knowledge and scientific ways of thinking for individual and social purposes. (p. 3)

Nowhere in the scientific literacy definition are the words reading, writing, or communication explicit. Yet, I believe that my students can only become scientifically literate if they also improve their general literacy skills. I also agree with Ediger (1993) that interest, meaning, and purpose are important in teaching writing in any subject area.

My beliefs in the value of writing as a learning tool have deep roots in the research on teaching writing in content areas (Britton, Burgess, Martin, McLeod, & Rosen, 1975; Emig, 1983, Moffett, 1968; Newell, 2006; Peterson, 2005). Writing is a process that helps learners to think deeply about ideas and information they encounter through reading, listening, viewing, and physically experiencing the world around them. Peterson (2005) explains that “writing helps students make sense of the rolling, backtracking highway of thoughts running through their heads. The written words, sentences, and paragraphs give thoughts some shape and form . . . the very act of searching for words and then rubbing them up against each other creates spaces for new understandings to emerge” (p. 3). These beliefs underpin the action research study that Shelley and I engaged in over a two-year period.

Teaching Writing in Science

The unit of study in both years of our action research study was “Mechanical Advantage and Efficiency,” a physics strand of the Grade 8 provincial Science and Technology curriculum. In the first year, I invited students to use any genre they wanted to communicate which procedures they had used and what they had learned during their hands-on activity (building a catapult and calculating the mechanical advantage of the lever built in it). In the second year, the writing activity involved students demonstrating their understanding of the concepts learned in class using a genre...
of their choice. I wanted students to stretch their science writing beyond the traditional laboratory report (which includes Purpose, Materials, Procedure, etc.). These usually unmotivating laboratory reports generally leave little room for the application of science concepts to different settings, leading to the oft-heard lament, "I hate lab reports."

To begin, I introduced students to the concepts through a vocabulary activity (see Fig. 1) and a series of hands-on activities that included experimenting with different types of levers, building a

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<thead>
<tr>
<th>Name:</th>
<th>Date:</th>
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<table>
<thead>
<tr>
<th>WORD</th>
<th>What I Think It Means</th>
<th>Think, Pair, Share</th>
<th>Standard Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEVER</td>
<td>A device used to lift objects using a teeter-totter motion (i.e., a jack) (Include a sketch here)</td>
<td>Something used to balance objects or lift things</td>
<td>a) A machine consisting of a bar that is free to rotate around a fixed point b) Changing the amount of force that must be exerted to move an object</td>
</tr>
<tr>
<td>FULCRUM</td>
<td>A force</td>
<td>A type of material</td>
<td>The point of a lever that does not move</td>
</tr>
<tr>
<td>LOAD</td>
<td>The weight the object carries</td>
<td>The object that needs to be lifted, or the weight that the object carries</td>
<td>The weight of an object that is moved or lifted by a machine, or the resistance to movement that a machine must overcome</td>
</tr>
<tr>
<td>EFFORT</td>
<td>The amount of strength needed to move something</td>
<td>The object that helps lift the load</td>
<td>The force supplied to any machine to produce an action</td>
</tr>
<tr>
<td>GEAR</td>
<td>A wheel with teeth that grip into another gear</td>
<td>Wheel-type object that helps monitor or move another object</td>
<td>A rotating wheel-like device with teeth around its rim</td>
</tr>
<tr>
<td>GEAR TRAIN</td>
<td>A train/row of gears (Include a sketch here)</td>
<td>A row of gears, or a lot of gears connected together</td>
<td>A group of two or more gears that are meshed together</td>
</tr>
<tr>
<td>PULLEY</td>
<td>A wheel used to even out the pressure on a rope/string/chain (Include a sketch here)</td>
<td>Something that pulls with effort</td>
<td>A wheel with a grooved rim to guide a rope or chain that runs along the groove, used to transmit or change the direction of force</td>
</tr>
<tr>
<td>ERGONOMICS</td>
<td>Something to do with machinery</td>
<td>The process of making practical and aesthetically pleasant buildings</td>
<td>The field that studies the design of homes and work environments that best suit the human body</td>
</tr>
</tbody>
</table>

Figure 1. Word anticipation guide

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SIDE TRIP: RESOURCES AND INFORMATION FOR CONTENT-AREA LITERACY IN SCIENCE


Of special interest to science teachers and teacher educators is this edited text by E. Wendy Saul with 24 chapters exploring the science-literacy connection. The text essentially provides information about how and why teachers can help students explore, inquire, talk, and write about science concepts.


This research-based article gives information on practical applications in the classroom, describing, for example, students' peer-written experiment manuals and advice letters.


This article describes several instructional strategies from the perspective of a middle school science teacher whose goal is to promote passion for learning by reading and writing in science.

- The National Science Teachers Association has focused its attention on writing in the middle school science class in its April 2006 edition of Science Scope. There are articles on learning logs, kinesthetic writing, interactive notebooks for inquiry-based science, writing through inquiry, to name a few.

- Additional teaching tips can be found in Sneed Collard's article, "Using science books to teach literacy and save the planet" in The Reading Teacher (2003, 57(3), pp. 280–283). As an author of children's books, he shows how science books can be used for storytelling, writing organization and voice, helping students connect with the information presented.

- For many additional ideas on implementing writing in science settings, access "Integrating Writing into the Science Classroom" at the following website: http://www.glencoe.com/sec/teachingtoday/subject/int_writing_science.phtml

- Another good place to begin investigating the integration of writing in the science classroom is the Northwest Regional Educational Laboratory at http://www.nwrel.org/request/2004dec/classroom.html

—Joyce Brigman and Karen Wood

pulley system, and calculating the mechanical advantage of systems of levers and pulleys. All of these activities helped students develop understandings that they would draw upon in their writing.

To introduce their writing assignment, I read to students the science fiction story “Alien Games” (Griessman, 2002). In the story, one of the characters tries to retrieve a ball from a forbidden alien city using a system of pulleys and gears to fit on a robot toy. My students and I then identified science elements in the story and the contexts in which they were used. We discussed how the author incorporated the science concepts into the story. I also gave students an assessment rubric to show what I expected in their writing.

Students began planning, gathering information (through reading and hands-on activities related to the topic), and drafting their writing. I allotted four 40-minute periods for in-class writing and peer editing. In other classes, all of the time was used for reading, discussing, and hands-on activities. Students submitted a first draft of their writing for my feedback on how appropriately the science concepts were being utilized, then revised and exchanged their second drafts with peers for additional feedback and peer editing.
Eighth-grade Students’ Writing and Writing Processes

Students in the first year of the action research project wrote in groups of four—two girls and two boys. In the second year, students wrote alone or with a partner. We have permission to discuss the writing of two of the groups from the first year and nine students in the second year. These nine students included three boys and two girls writing independently and two groups of girls. In interviews, we asked students about their decisions regarding the genres and topics they chose, as well as how they incorporated science concepts in their writing, how satisfied they were with the way they demonstrated science concepts in their writing, and the types of writing they preferred in science. We analyzed student interview responses and writing by looking for evidence of: 1) students’ motivation and science learning; 2) students’ genre knowledge; and 3) students’ sense of audience.

Students’ Motivation and Science Learning

Students showed great initiative by doing much of the writing at home on word processors. The groups of students in the first year spent a lot of time using MSN Messenger to plan and draft their writing. Many students also used the Internet at home to expand their knowledge base about simple machines and the topic of their writing. Vishnu, for example, read about Egyptian history to prepare for his story about an Egyptian expedition. (Please note that all names are pseudonyms.) Malika, a student who had consistently demonstrated enormous difficulties in understanding concepts and handing in work on time, created a cartoon. Not only was she excited about the whole project, she handed in her work before everybody else and showed clearly that she had grasped the science concepts.

Students felt that writing about the science concepts using genres of their choice led to deeper understanding. Vishnu explained, “You’re the one that’s teaching yourself. Instead of having some book you’ve got to study from, you’re teaching yourself by writing your own story.” One of the girls who had collaboratively written a story about a girl driving a car into a ditch explained, “When the character went into the ditch, I didn’t know exactly how to pull them out. So I thought about it, and all of a sudden all the things I learned in science just started popping up. I put some of those concepts together and I just made it; it just happened.”

Through writing, students thought about the work of simple machines in contexts different from the ones introduced in class. For example, in his story, “The Worst Egyptian Expedition,” Vishnu described a pulley system used to rescue the protagonists:

Kishwatembo carved too many really sharp hooks from the bones he was chewing. XJ9 lent us some rope from its storage cabinet. Because our robot friend was so unique, it could perform some really neat things. XJ9 turned its arms into guns and shot one of the many hooks into the ceiling and the other hook, attached with the rope, through the first hook and onto the other side. Using one of Kishwatembo’s frisbees, XJ9 cut a groove along the edges and, using Poopypants’ calculations, shot it right at the rope, making a simple pulley. Ok, good, halfway done. For the lever, we stuck several of the bones Kishwatembo found together with special glue made by XJ9’s chemicals to make the base. The remainder of Kishwatembo’s frisbees were used to construct the fulcrum, with all of us being the effort. First, we carefully latched the enormous chest with the pulley and put it on the lever. At the exact moment, we all jumped on the other end, sending the chest right into Kishwatembo’s open arms. BULLSEYE! Joy to the world!

It’s all been the high life from that point on. The treasure chest turned out to be over 800 billion dollars in value! ...

Students demonstrated the general understanding that the purpose for simple machines is
to provide mechanical advantage, or in their own words, make “work easier.” For the most part, the applications were limited to lifting mechanisms, most likely because this is an application with which students are most familiar. For example, in Nishanthi’s mystery story, the kidnapper is caught by a pulley and inclined plane system rigged up by the detective. In Tony’s adventure story, a pulley system and gear train are used to rescue a dog hanging onto a ledge following a chase of the villain.

In some cases, students thought about the science as they began to plan their writing and in other cases, students considered incorporating the science knowledge after they had begun writing. Vishnu, for example, chose an ancient Egyptian setting because it was “the most mysterious and easiest to add the science to.” He knew his characters would be facing a problem that simple machines would help to solve. Students who wrote adventure stories generally found it easy to incorporate the science concepts because they fit naturally within the context of solving conflicts in adventure stories.

Students’ Genre Knowledge

There was great variety in the genres students used to convey the science concepts, though stories were the most common. One group in the first year wrote a script for a play; the other wrote a historical fiction story. In the second year, two boys wrote adventure stories and one wrote a parody of Charles Dickens’s “A Christmas Carol.” One girl created a cartoon and the other wrote a detective story. One group of girls wrote a letter asking for advice in a teen magazine advice column and the other wrote a realistic fiction story.

Students in both years showed extensive genre knowledge, explaining that they used the genres that they enjoyed reading, and thus were very familiar with. Malika, for example, said, “I just thought it would be interesting to write about comics because usually most of the books I do read are comic books and magazines and stuff.” The advice column, the adventure and mystery stories, and the play used tones and formats that were very true to the genre. Hemant began his parody of Dickens’s “A Christmas Carol” by introducing the Scrooge character and the character flaws that the ghosts of Mechanical Advantage would attempt to help him overcome. He also used foreshadowing in the final sentences of this excerpt:

Jim was a very lazy and ignorant kid. “Who needs mechanical advantage!” he would always say. Of course, this always made his life harder, especially since he wasn’t that strong himself. Soon he began to forget what mechanical advantage really was, and was simply lost in a world of hard work. He couldn’t keep up with it, and his laziness only made matters worse. It seemed that there was no hope left for this poor soul. Fortunately for him, though, he was being watched. And hope would come sooner than he thought.

Tony, the author of the Ninja story, showed his knowledge of ways to entertain and engage his readers using the adventure genre, saying that he would like to revise his story by having the characters attempt to solve the problem and fail a couple of times. He wanted to build greater suspense than he felt his story did with the initial successful attempt.

Students brought in characters and story lines from other texts they had read and from their real life experiences. The story about a driver’s test was inspired by the sister of one writer. Students who wrote the historical fiction story made connections to other texts by bringing in the three musketeers as catapult launchers and by referring to Atlantis in the following: “Some say it was his shrilling scream that made Atlantis disappear . . . but that, my friends, we will never know.”

Students’ Sense of Audience

Awareness of the classroom audience was uppermost in students’ minds as they wrote. The two girls who wrote an advice column had conducted a survey of friends and siblings, finding out that “everyone likes magazines.” Similarly, Malika explained that she thought the cartoon form was “more interesting and people could relate to it and it’s a good kid thing.”

Many students used humor to entertain their peer audience. In Malika’s cartoon, for example, Jon, the protagonist, cleaned up his room by cata-
pulting the junk out the window. Unfortunately, his friend was standing outside the window, so Jon had to clean up his friend before he could play with him. Similarly, Hemant ended his story with: "The 3 ghosts quickly huddled together and before you could say 'mechanical advantage,' they disappeared. Jim sighed and then climbed into his bed. 'Wow,' he said. 'I really need to lay off the junk food.'" The two girls who wrote a realistic story about a driver's test used humorous asides to draw in their audience, as in the following excerpt: "I sat in the front seat of my mom's car scared out of my wits (my mom tends to speed up a bit) and I wasn't scared because of her ability to drive (quite low) but I was scared because I would have to do my driver's test in about an hour and 10 minutes." Exaggeration was used for humorous effect in many stories. In the driver's test story, the wait for the driving tester was described in this way: "An hour and 15 snack bar visits later, it was my turn to enter the driving test area."

Some students showed their sense of audience by giving hints to their readers to help them navigate the writing. For example, the group that wrote the historical fiction explained to their audience, "After each try, the distance accomplished by the catapult was recorded in Roman Numerals (as Roman Numerals were most commonly used in that age) but for your convenience, we have recorded the data in normal numbers." Malika numbered the cartoon blocks to help readers follow the sequence of events. She used typewritten words for the narration and printed the dialogue and sound effects. Tracy used a different font for the ransom note from the kidnapper.

Although the assignment did not require the use of visual images, most of the students included them—either their own drawings and diagrams or Internet pictures of cartoon characters. The first-year students' historical fiction story also contained a table and graph of distances covered by the Hershey kisses when they were launched by catapults. Many students imported graphics from Internet sources for the covers of their writing. They also drew diagrams to show how the simple machines worked and drew pictures of the characters. Students explained that they incorporated these visuals to clarify information for readers and to add to the interest value of the writing. For example, Nishanthi included a drawing of the inclined plane and pulley used to apprehend the baby kidnapper.

**Recommendations for Language Arts Teachers**

Our two-year project opened our eyes to other possibilities for teaching writing in science. We make the following recommendations to language arts teachers who would like to teach writing using content area topics, or who would like to collaborate with science teachers in their schools.

- Language arts and science teachers could co-plan and/or co-teach units where writing projects come from science content. The content area classes could be used to help students gather information for their writing. Writer's workshop could be used for the actual writing and writing instruction, including the mini-lessons, conferencing, and sharing of the writing in small groups, with a partner, or with the whole class.

- Elements of writing, such as developing characters in fiction writing, supporting the main point with examples and details in non-narrative writing, or making decisions about line breaks in poetry writing, could be the focus of mini-lessons. Mini-lessons could also address writing decisions, such as how to determine the types of information that will be important and how to record the information so it can be used in their writing.

- The use of exemplars, such as excellent and weaker writing composed by students in previous years, could be used to reinforce students' understanding of the assignment expectations when the scoring rubric is introduced. In mini-lessons, teachers and their students could analyze the exemplars before students embark on their own writing.
• Language arts and science teachers could collaboratively assess the writing. Assessment criteria for the writing would reflect both language arts and content objectives (see Figure 2 for an example).

Science opens up a universe of topics for students to write about in writers' workshop. At the same time, writing helps students to deepen their understanding and to connect science to their everyday lives, while making science more interesting. In middle schools, it is time for language arts teachers to visit the science wings in their schools and invite science teachers to collaborate in teaching writing.

References


American Association for the Advancement of Science. (1989). *Science for all Americans: A project 2061 on literacy goals in science, mathematics, and technology*. Washington, DC.


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### Figure 2. Checklist for assessing content area writing

| Content | Points out of
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1. Provides information about all concepts</td>
<td>[ ]</td>
</tr>
<tr>
<td>2. Provides accurate information about all concepts</td>
<td>[ ]</td>
</tr>
<tr>
<td>3. Creates a context that presents a thoughtful and perhaps new way of looking at the concept</td>
<td>[ ]</td>
</tr>
<tr>
<td>4. Provides specific supporting details consistently so the writing is easy to understand and creative/engaging</td>
<td>[ ]</td>
</tr>
<tr>
<td>5. Consistently shows connections between the concepts</td>
<td>[ ]</td>
</tr>
<tr>
<td>6. Maintains a clear focus</td>
<td>[ ]</td>
</tr>
<tr>
<td>7. Uses multiple sources of information</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

### Organization

| 1. Beginning and ending clearly identify what writer is trying to achieve | [ ] |
| 2. Uses the structure of the genre to communicate effectively | [ ] |

### Style

| 1. Uses language appropriate for the audience and genre | [ ] |
| 2. Uses specific words and expressions, a variety of sentence structures/line breaks/graphic designs in a creative and effective way | [ ] |
| 3. Readers get a clear sense of the writer's voice | [ ] |

### Conventions

| 1. Consistently and effectively uses spelling, grammar, and punctuation | [ ] |

| Total | [ ] |

(From Peterson, 2005, p. 129).

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