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Writing to Learn Science

Rae Bruce and Rodney Mansfield

In the science lab students gather around a table with two teachers and an assistant principal. They all hold in their hands computer-printed books entitled *Glimpses of Nature*. One by one, the students stand to read and share their poems. Some read with confidence, others hesitantly. These poems about photosynthesis, population density on specific natural sites, and symbiotic relationships involve looking at scientific concepts through lateral thinking. Although most students are reading the first real poem they've ever written, these poems brim with analogy and metaphor.

As the group turns the pages of *Glimpses of Nature*, Rod Mansfield, the science teacher, and Rae Bruce, the English teacher, take turns reading their own poems. Everyone smiles, for this is a celebration of publication and learning. Rod gets applause for his poem about the stately pine; students applaud not only the poem but also the risk he's taken by writing poetry with them.

The assistant principal offers enthusiastic comments and suggests other nature poems for students to read. Then slapping the book against his leg, he goes directly to a budget meeting where he will use the poems as an argument for interdisciplinary projects such as the writing center. He leaves behind a room full of students autographing each other's poems and congratulating one another on their work.

This booklet of poems attracts attention and positive comment from people outside the project. Because of the analogical thinking required, these poems are very important; however, they are only one component of a carefully constructed series of writing activities that require students to write as a way of learning and exploring new concepts. Both Rod and Rae want students not only to write to learn in this course but also to realize that writing is important outside of

English class, that it is a tool for learning and thinking, and that it is important for communication of ideas in every discipline.

The students who have taken part in these writing projects were heterogeneously grouped and at various times have included all academic levels in the school. However, when Rod and Rae started the project, most of the students were of average ability and many were not college bound. This project has shown Rod and Rae that the kind of thinking skills their projects included can be done by all levels of students. Enthusiasm for the course has encouraged more college-bound students to enroll.

At the inception of this project Merrimack High School in Merrimack, New Hampshire, had recently embraced a new philosophy as part of the reaccreditation process by the New England Association of Secondary Schools and Colleges. This philosophy, adopted enthusiastically by the faculty, included a strong interdisciplinary thrust. Using the new philosophy to support their belief in writing as a way of learning, Rae and her department head, Deborah Woelflein, developed THE WRITE ROOM, an interdisciplinary writing center that provides staff and students an opportunity to focus on writing in all disciplines.

Therefore, when Rod started to develop his new environmental science course, both the interdisciplinary emphasis of the school philosophy and the availability of THE WRITE ROOM were natural factors to incorporate in the new syllabus. Collaborative work was a natural outgrowth of the administration and faculty support for an interdisciplinary approach to learning.

Originally, the project came about informally over coffee in the teachers' room. In the spring of 1989, as Rod discussed the new course and his plans for students to adopt a natural site for study, Rae suggested that journals would provide a good way for students to record their observations, reflect on them later, and connect them with the course content. This feeling led Rae to experiment with journal keeping that summer. She soon realized that double-entry journals would provide the best format for this kind of thinking.

In the fall Rod and Rae began to implement the project, discussing ideas in both formal and informal meetings and collaborating to develop activities to fit the objectives of the course. As the course evolved, the two teachers developed six major course assignments incorporating content objectives and strategies to facilitate student learning through specific writing projects:

- a double-entry journal
- a site description
- speciation of the site
- paragraphs about relationships among various aspects of the site

- a free-verse poem
- a synthesis paper applying and relating course content to observations of the site

During the first semester, the teachers expanded their collaboration to include the computer specialist so that students could take advantage of both word processing and data bases as tools for facilitating learning.

The Double-Entry Journal

The double-entry journal provides the foundation for all writing to learn activities and helps meet course objectives:

1. Students will increase their powers of observation of natural phenomena and begin to focus on important details within the setting. Students will be able to distinguish between significant and irrelevant factors in any ecosystem.
2. Students will be able to recognize and document the unique role (niche) that each species plays within the ecosystem.

Early in the semester Rae modeled for students a brief excerpt from her double-entry journal in which she kept her observations of sunfish and their nests in a New Hampshire lake. Making the point that she is not a scientist, she shared her entries, which included observations of size, shape, and changes both in the sunfish and in their nests. Putting the entries on the overhead projector, she emphasized that her right-hand entries went beyond pure observation by hypothesizing that one fish seemed to guard each nest, that the nests consist of gravel piled like a moat around sand, and that the fish guard the nest because it probably contains eggs. She stated that further research in the school media center confirmed her assumptions.

When assigning the journal, Rod instructed students to choose a site easily accessible to their homes and of a minimum size of ten meters by ten meters. He required students to make three visits a week, recording observations and impressions in a double-entry journal. Following Rae's model, students set up journals placing their observations on the left page and their comments, questions, hypotheses, content connections, and plans for future tests and observations on the right.

In order to address the objective of having students increase their powers of observation, Rae presented material on observing and recording sensory detail. The class and two teachers discussed details that might be observed. The following interplay among Rod, Rae, and the students demonstrates how the teachers responded to the students' question, "Where do we start?":

Rod: From what perspective or point of view might you describe your site?

Student: From one corner to another.

Student: From biggest species to smallest.

Rae: Or pretend you're taking a walk through the site.

Student: Yes.

Rod: Is your site two- or three-dimensional?

Student: You mean I might describe it from bottom up or top down?

Rae: Yes, what other senses might you use to describe the site?

Students: Hearing? smell? touch?

Rod: How about focusing on time of day? Does it look different in the evening than in the morning?

Rae: Or try different weather conditions.

Thus the teachers encouraged students to explore varied ways to communicate the qualities of their sites and the value of looking at them from different perspectives. To further focus and sharpen their observations, they also suggested that on some visits, students record details about one species or attribute and make as many observations as possible.

Following this discussion and after students had made several entries and refined their observation techniques, Rae returned to the class to have them write about their feelings, questions, and concerns. After a focused free write of five minutes, students shared their writing. One difficulty they expressed was finding enough material for the right-hand side. Both teachers asked some students to read sample right-hand entries and had the class collaborate on questions that they might ask and assumptions they might make.

Samples from student journals show that in spite of their initial difficulty in making connections and forming hypotheses based on their observations, they soon became adept at these thinking skills. On the left side of his journal, Jason notes that "about six squirrels are very active collecting acorns, even though they haven't ripened."; on the right side he states that "it's [squirrel activity] very odd because some days I don't see any," and then he speculates that "maybe it's the time of day or the weather." About two weeks later on a blustery day, he observes that after a morning's rain "a huge patch of moss seems to be losing its radiant greenness." On the right side of his journal, he infers that the wind is drying out the moss and causing it to change color.

Kathy's site included a local pond where she observed that the water level had receded, probably because it hadn't rained for some time. On September 23 she notes that there is "green algae stuff on the

surface and edges of the pond." On the October 9 she notes that the algae is nearly gone and wonders why. Her question illustrates the changing patterns in nature that she notices over a period of time.

As the semester progresses students become more efficient at observation and use their journals more frequently to form scientific hypotheses. Many begin to recognize that writing not only records observations but also helps connect recorded observations to the course content.

Speciation

The initial journal entries increased students' awareness of the variety of life forms in the sites that they had selected for study. To enhance their awareness of the multiplicity of life forms found in any natural site, the students were required to collect (and often return) and identify as many species as possible from their site. At the beginning students expected to identify four or five species and were amazed that their completed species lists contained between thirty and fifty entries. An auxiliary competency developed as a result of this activity was the ability to use efficiently a dichotomous key to identify the various forms of life. This also led students to the realization that mammals or other high life forms were not the only residents of their sites. The computer teacher assisted students in this endeavor by using a data base to document the various species collected and identified. In the future it is anticipated that through a telecommunications network students will be able to compare the species identified on a site in New Hampshire with those identified by other environmental science students in different regions of the United States or perhaps even in other countries. This will allow students to compare ecosystems and to recognize that different species serve similar functions (niches) in various ecosystems around the country or world.

The Site Description

The first paper of the semester is a one-page description of the student's site. Limiting the papers to one page forces students to concentrate on the most important aspects of their sites and to choose words carefully. Bringing in excerpts from Annie Dillard's *Pilgrim at Tinker's Creek* (1974) to use as models, Rae reads them with the students and points out Dillard's use of sensory detail; Rod emphasizes Dillard's scientific content and use of scientific language. Both teachers emphasize that good scientific writing need not be dull, but should include sensory detail, scientific language used in a context that makes it clear, and some sort of order.

When students ask how to start, Rae and Rod refer to the prior discussion on observing from different perspectives, utilizing various senses. They state that although many starting places would be appropriate, the perspective chosen determines to some extent the order of the piece. Students return to their journals for details to start and soon discover that limiting their description to one word-processed page means choosing details carefully.

Relationship Paragraphs

These descriptions lead directly to writing paragraphs exploring the relationship between two parts of the ecosystem. Using as a model an essay (1990) about a lake beneath Yellowstone Park, Rae asks students to write sentences showing the relationships between thermal activity in this lake and its location over a hot spot in the earth's crust. Then students turn to their journals and list relationships they might explore on their own sites; for example, the sneeze weed and the caterpillar, the Eastern gray squirrel and a tree, migrating birds and a pond. The assignment asks students to state the relationship between two parts of the ecosystem clearly in the topic sentence and to develop the paragraph using details from their journals. Writing these paragraphs sometimes involves research about a species and also helps students leap from description to the metaphor needed in the next assignment.

The Free-Verse Poetry

The poetry project aroused a good deal of positive interest from faculty and parents and also some anxiety among students. For many students these would be the first poems they had written. Some wondered how the teachers could defend composing poetry in a science class. A look at the poems shows doubters that they include real science content.

Rae acknowledges students' anxiety by admitting that she used to feel the same way. She tells them, "I know you can all write poetry because I'll show you ways into a poem, ways to tap the creativity that's in all of you. If I can do it, you can!" She gives examples of the metaphors that already exist in science, for example, *the food chain*, and a nebula's being called *a nursery for the stars*.

Because both teachers believe strongly in their objectives for students to use both linear and analogical thought, to integrate ideas by using metaphor, and to perceive the site or a species in new ways, they address all questions and continue to reassure nervous students. Three years later, this assignment has become an accepted, enjoyable part of the curriculum.

As the first class started the poetry project, Rae introduced lateral thinking by mentioning that many people had seen the apple fall from the tree before Newton did. However, he formed the law of universal gravitation because he looked at a common occurrence and related it to all motion in the universe. Only he asked why it happened and worked out the theory of gravitational attraction. Important discoveries often involve looking at phenomena in an unconventional way, making associations among previously unconnected material.

To assist students in getting started, Rae demonstrates clustering (mapping) on the overhead projector. Using a common word such as *Thanksgiving* as her nucleus, she soon fills the screen with her personal connections to Thanksgiving. Then she clusters again using *sunfish* as her nucleus, spreading her cluster by drawing circles until words like *guard*, *moat*, *sand*, and *flick* appear; soon obvious connections between parts of the cluster appear. Students quickly recognize the power of clustering to generate metaphor.

Next, students choose a nucleus word related to their site and start to cluster. Rae urges students to be free and relaxed. Rod sits at a table clustering with his students. Rae circles the room encouraging the reluctant. Soon students begin to talk, sharing their clusters and developing metaphors of their own. One girl announces, "Water is a mother, parent, transporter of nutrients, nourisher of all cells." She has started a poem. Rae asks students to construct three metaphorical sentences showing new ways of looking at some aspect of the site.

The next day, Rae passes out copies of her poem *Six Ways of Looking at a Sunfish*. Students note the scientific nomenclature and the use of elements from her cluster. Then they share the sentences they have developed from their clusters. In order to help them develop their images, Rae asks the girl with the water metaphor, "What does a mother do that water does?" The girl's answer sets her to scribbling the first draft of her poem. Moving around the room, Rae asks other students similar questions and soon nearly everyone is writing.

They go away with an assignment that reads: "Write a free-verse poem about some aspect of your site. Include concrete, sensory detail. Do not rhyme. Use scientific content and language. Use condensed language."

When Rae returns to the class, students hold up their papers and protest, "But this isn't a poem." Rae asks students to put their drafts on the overhead projector and assists them in condensing language. She suggests that students play with line breaks, pointing out the shape of the poem on the page and the difference in emphasis created by changing lineation.

Later, using a word processor helps students to play with line breaks and word arrangements. Julie's language takes on a poetic

quality as she makes her leaves "swoosh in whirlwinds." More important, the poems show that many have perceived their subjects in new ways. John, who has never written a poem before, writes about the gray squirrel, "Zing! Zing! Zoom and he's gone!!" The squirrel uses that nest "as a pantry for the food!" John has internalized the motion and food-gathering habits of the squirrel.

Chrissy ends her poem with a metaphor that shows clearly her understanding of the chemical makeup of natural sugar. "Water and CO_2 combine to mother glucose."

The first stanza of David's poem, *The Floating Ecosystem*, reads

> a log on the water
> . . . like a traveling barge,
> [has] passengers from all Kingdoms,
> coming from all sides.

Using a bit of humor, he personifies the animals in a twentieth-century human context.

> In daylight, a beach,
> where turtles and frogs
> use this gliding mobile home
> as a tanning salon
> warming their slimy bodies.

And his ending lines illustrate his understanding of the floating log's niche in the ecosystem:

> Remnant of a once strong tree,
> Now foundation of aquatic life.

Jason's poem illustrates that scientific writing need not be dull, but may include lovely images to communicate scientific content. Calling the falling leaves *Autumn's Orphans*, he ends his first stanza with

> Slowly leaves combust into
> blazes of orange, gold and crimson.

And his second stanza uses scientific terminology in a way that makes the term easily understood by the nonscientist:

> Trees mourn over losing their *annualities*.

He finishes by spiritualizing the annual cycle of rebirth:

> With the falling snow, the leaves pass on,
> their spirits melting into the earth.
> They find their parent tree and travel its roots
> to become the leaves of spring.

Requiring students to research a specific species to write about

often helps them discover metaphors for their poems. These metaphors lead them to increased understanding of relationships among aspects of the natural world. Mark's poem illustrates the advantage of asking students to concentrate on a single species or relationship. Note that he has extended his metaphor throughout the poem to show the strangling effect the grape vine has on its host tree. He starts by describing the "Hard gripping twine amongst the ... branches" and continues in the second stanza with

> The paralyzing python grasps
> the masculine tree trunk,
> takes hold to make a strangling stand,
> expands the reach and squeezes harder,
> aggressively saps the tree's power,
> Slowly takes it down.

Mark's use of strong verbs makes the force of his language match the force of the vine on the tree. He understands both the relationship between the tree and the vine and the use of words to match his content. Thus, the writing of free-verse poems helps students to integrate science content and practice their writing skills at the same time.

The Final Synthesis

Sitting in the chairs in the teachers' room as they had the previous spring, Rod and Rae found that the final project of the semester generated itself as casually as the collaboration had begun. Rae had just reproduced copies of an assignment for her college-bound juniors. She handed it to Rod, saying, "What we need to draw the journals together is an activity like this one."

Rod read directions for a synthesis of a reading response journal on a novel. He smiled and said, "I see what you mean. I can arrange for my science students to do the same kind of thinking by writing this in terms of the course content." The assignment he worked out included writing about three major aspects of the site and relating them to five major ecological principles studied in the course. Further he asked students to predict conditions on their sites at some future time, giving an ecological rationale for their prediction.

The second year of the project, the synthesis assignment included a part in which students expressed their feelings about their adopted site. Students became very fond of their site during their semester of study and wanted to express that feeling. This need showed that they had met an important objective for both teachers, developing new attitudes toward the natural world.

One of Kim's final entries demonstrates the effect of the semester's work on her:

> At first, I would look around sometimes, not closely, and think that all I saw was green and trees. As time went by, I got closer and closer, looked at berries, leaves, moss, and other things and inspected them. I got more in touch with my site. But, at the same time, I noticed the environment as a whole. While driving, I still look around and think about it. For instance, how much I hate litter and plastic, and trying to think of ways to make people more aware. My site and journal have made a definite impact on me, both at my site and out of it.

In addition, Kim became one of the student leaders in a full-day celebration of Earth Day that spring. She had not only learned ecological principles but also believed in them strongly enough to volunteer many hours helping organize the Earth Day celebration. Kim is only one of many students who have been affected by their participation in this project. Unlike Kim, many of them will not go on to college; this course in their senior year of high school is one of the last chances the educational system has to help them develop lifelong environmental attitudes before they become citizens whose decisions will affect the future of the planet.

Authors' Note

The administration supported the project in several ways as it developed. Deborah Woelflein, chairperson of the English department, covered Rae's classes so that she could meet with Rod's science classes during their regular period. So that THE WRITE ROOM's interdisciplinary objectives might be fulfilled, she suggested that collaboration with teachers in other disciplines be one of Rae's objectives for the next year. Thus Rae's work on the collaboration had official blessing. The chairperson of the science department gave Rod complete freedom in structuring the new curriculum.

The environmental science project was among the first of the interdisciplinary projects at Merrimack High School. Other teachers developed projects soon after the philosophy was adopted. The enthusiasm of teachers involved in these projects spread rapidly and continues at the present time. An active interdisciplinary committee tracks interdisciplinary projects and will record them on a data base for teacher reference. Teachers in every department use interdisciplinary content either in collaboration with other teachers or by incorporating content from other disciplines in their curriculum. Presently a small group of teachers from nearly every department is meeting to put together a core curriculum for a ninth-grade pilot program.

References

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