
Learning to Read, Create, and Disrupt the Powerful Messages of Science Learning Environments

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In this novel case, Bonnie introduces semiotic interpretation as a way of looking at what goes on in science classrooms. Semiotic interpretation is based on an understanding of the values and beliefs of the dominant culture within a society. It documents how student teachers learn to interpret science learning environments using the resources of a semiotic interpretive perspective. The case follows the experiences and discussions of Casey, a student teacher, and Rachel, a biology teacher with 26 years of experience who was hosting Casey in her classroom, as they work with Bonnie to examine the signs and symbols of the science learning environment.

The student teachers had been given an assignment that involves investigating the semiotic messages of science learning in school settings. The assignment asked them not only to observe and participate in classroom settings but also to engage in an exploration of the entire school to consider the cultural symbols, signs, and signification systems, or semiotic messages, that accompany students' learning experiences in science. Rachel and I had worked together before on a curriculum institute project, and she was eager to engage in conversation with us. "I've become very interested in what Casey is doing," she told me. "I didn't expect that following Casey's work would cause me to begin to look so differently at teaching and learning. I am now seeing messages about science that are conveyed by the environment of learning itself! Casey is documenting this stuff. I'm just trying to figure out now what I can do with this information—to make these messages about science as positive as possible for students. I can see that there are aspects of the learning

environment that do have an impact and I want to make them powerful messages for students." I was not surprised with Rachel's enthusiastic response. She long held an interest in looking deeply at her own practice and we welcomed her full participation in the project. Over several days, we explored the school environment together following the assignment guide, looking systematically at features of the environment. Excerpts from our inquiry and conversations, presented below, provided insight into novice and experienced teachers' views on the value of considering the cultural signs and systems of signification that are an important part of the school experience.

Approaching the School Building

We started by approaching the school building from the outside first, asking the three following questions: "What thinking do students bring to the school about science learning, and how do they conceptualize the building as a resource for knowledge of science?", "What are the messages of the school environment for students?", and "What do students know about the school and about the science learning that occurs there before coming to it for the first time?" Crestview Heights Junior/Senior High School was built in the 1960s. Some of the children in the community had parents who had been students there. The building had undergone renovations in 1989, but there had been no changes to the science area since the building was constructed. Casey commented, "I think that this speaks a message about how those who make decisions about renovations value science and science learning. They may think that science has not changed in 40 years, so teaching science is still the same." Rachel added, "There have been many new ideas about science teaching over the years and recently, yet our lab is almost identical to the one we used when I began teaching."

I mentioned that I thought many students come to school with distinct ideas about what learning science in high school is like through conversations with parents and through stories told by older siblings. Messages from these stories, passed on through the generations, build expectations and ideas about what they will do and how they are expected to act in science learning environments. We walked around the outside of the building and up from the street. Rachel pointed to a small garden patch. "We share this area with the junior high school. The students have put in some plants from a natural prairie grassland to see if they might be as successful in transplanting as botanists were in a university project, for example, with these fescue grasses." Casey remarked on how welcoming the garden looked, and how it seemed to speak a message for all who see it that something special is going on in teaching biology here. "It looks very well organized and systematic, scientific in the way the plot is set out with all the plantings. It would be great if there were some kind of sign here to tell anyone looking at it what is going on here." She continued, "It would also tell the community that there is something valuable taking place, some real learning." We talked about how the schoolyard speaks a message, not only to students in the environment, but also to members of the community about the school as a place where learning activity is taking place.

The School Entrance

We entered the building and stopped to consider the impression of signs and messages in the school entrance as a source of information about what might happen in the school. The first item in view was a display case, similar to those typically found in almost all high school settings. We looked at the many trophies awarded to the school over the years for athletic achievements.

Casey laughed. "There certainly is a message here," she said. "I had never thought of it," added Rachel, "but I guess it does speak about what is important in the school. Athletics isn't really our main focus, but the trophy case would suggest that it is very important to anyone entering the school." "Well, the message I was reading," said Casey, "is how much more important the men's teams seem to be than the women's." We moved closer to count the assemblage of awards: men's hockey, 4; men's basketball, 3; men's football, 2; men's wrestling, 1; men's baseball, 1; men's tennis, 1; women's gymnastics, 1; and women's volleyball, 1. "We have had some city-wide winners of the science fair," Rachel continued. "They should somehow be represented here. But then again, I'm not so certain that I like emphasizing the competitiveness of any of this. I would rather see students' work displayed or some other form of recognition of their work." We walked along the hallways and noticed the



FIGURE 5.1 School entrance trophy case.

many athletic club photographs on the walls, spanning the years, the majority being of all-male teams. Casey observed, "Well, if there are students who look carefully, they will see that more recently there are pictures of more girls' teams. But then, it all seems to end around 1990 or so. There are no more pictures after that."

We considered together how cultural values and ideas guide the design and organization of buildings. As cultural territories, buildings embody beliefs valued by members of society. In traditional times, the larger buildings in many Western cultures were religious, drawing attention to them as the more powerful institutions in the community. More recently, the dominant force of Western societies is its economic institutions, hence their much larger presence. The World Trade Center stood as a symbol of Western economic power. We can see signs marking cultural values that are embodied in school buildings. In Canada, elementary schools constructed in the early 1900s that still stand have separate entrances marked "Boys" and "Girls." These signs, carved onto outside building archways, are now ignored, a comment on distinctions made about gender in the past that are not currently held.

Messages in the Classroom

Continuing down the hall we came to Rachel's classroom. A sign on the door read, "Biology." Also on the door we noted a hazardous materials sign and on a small door to the left, a symbol indicating danger and a card that read, "Keep Out." Inside the classroom, students were seated at large, black shiny tables, talking with one another, some with open books on the table in front of them. As soon as Rachel entered the room, there was a drop in the volume of conversation. She made her way to a lecture and demonstration table that had been built up on a raised platform at the front of the class, opened her class record book, and waited for the first class bell to ring. There was an odor in the room. "How would you describe this odor?" I whispered to Casey as we took seats in the back of the room. "Biology class!" she laughed. It does tell you that you are in a place where there are chemicals. I will never forget this smell. I guess it is the sulfur that is strongest, acrid smell, but there is also the smell of formaldehyde. We talked about the association of smells and the experiences students have in high school classrooms. "Mine were very positive," Casey said, "but I know that some students have really negative associations with odors in biology labs. They are completely turned off by the smell!" Casey stated how memories of learning and the association of odors might be strong stimuli for some students for future aversion to science studies.

We listened as Rachel started the class.

RACHEL: Ok, you recall that today we are looking at the case study in this chapter on resistance to DDT. Let's just review what is meant by variability and why that is so important in thinking about pesticide applications. Who has a comment about that?
[Several students raise their hands.]

RACHEL: Din?

- DIN: Well it, um, they are there all the time.
- RACHEL: Ok, good. Explain that a bit more. What do you mean by "they"?
- DIN: Well, the population, any population has variation in . . . its chromosome structures. There is some variation there all the time. So when the pesticide is applied the ones that are different will . . . survive.
- RACHEL: And how do they survive? Hands?
- MARCUS: There are some that aren't killed because the DDT hits only certain ones.
- RACHEL: And what do we call that population? Adam?
- ADAM: The one that wasn't hit? Or the one that was?
- RACHEL: That's right, um, what I am getting at here—that there's a target population. This is the one that is killed by the pesticide. We want to be clear that the chromosomes in some individuals in that population are different . . . and what do we call that, how do we refer to that difference? Dawn?
- DAWN: Resistance.
- RACHEL: Ok, Dawn . . . and what makes it possible for the resistant strains to survive?
- DAWN: Well, the ones that were targeted by the DDT, in the case there, the lice there were eliminated, but the ones that had the different chromosomes, or they had different mutations and somehow that helped them get away. But down the line there are even more that become resistant because with each spraying this happens again, but they are still reproducing all the time; the ones that are resistant still have their reproducing cycle going on.
- RACHEL: Ok, so let's just recap before we go on . . . because we want to look at how this might be related to pesticides in the community.

The next day we explored portions of the transcript of the conversation and social interaction aspects between Rachel and the students for semiotic messages. I asked her if there was anything typical about this interaction, that is, if the pattern of dialogue was typical of the kind of conversation that students have with teachers in school settings. Rachel reflected, saying yes, that it was a very typical lesson introduction, a way that many teachers engage students in conversation. Viewed semiotically, we can see the pattern of interaction as a sign to students that creates expectations about how classroom conversation will take place: (a) The teacher begins the conversation, (b) she waits for students to raise their hands as a sign that they wish to contribute, and (c) the teacher calls upon them individually or asks another question designed to focus the discussion. Although this pattern of interaction shows students what to expect in science learning, it may also indicate to them that it is the teacher who holds power and control in the classroom. "It is the teacher who always knows all of the information," Casey remarked, "and it is only she who asks the questions. Also, she said she read in an article about how the podium can help students to focus their attention to the front of the room,

because, again, that is where the knowledge lies." And so in this ritual of interaction, we see messages that point clearly to students to tell them where they should look for information. At the same time, we may see messages that we do not want for students. Students may learn that *they* do not have significant ideas to contribute. They may not learn that it is good for them to ask questions, but that they will only answer questions in class. We talked about the many signs and systems of signs in the classroom setting that speak about what science is and about how science learning will proceed. As a cultural territory, the classroom presents a set of rules and regulations to students about what will happen during science learning. Students and teachers who inhabit classroom settings read and anticipate these rules as text and learn, through their experiences within the classroom and the seating arrangements, how one is expected to behave when engaging in science learning and when doing science. It is clear from the placement of tables and the podium in front of the class, and the fact that the teacher is standing at the front while the others are sitting, who is in charge here. There are clearly defined rules that students learn regarding who may speak and when, which most students have mastered even before entering the setting. For example, raising one's hand is a sign that one would like to offer information. But imagine the confusion of a student from another culture who comes into the learning setting not knowing the cultural rules, social dynamics, rhythms, and rituals of interaction that are acceptable here. "I often begin working to try to help student teachers learn how the environment can be read as a text in the classroom by considering the arrangement of furniture in the classroom," I said. "When we have moveable tables that promote discussion groups and the sharing of ideas, for example, that is a different statement about what we want to happen in the classroom than the one made with immovable tables and stools."

We had moved from the topic of building architecture to that of classroom organization and dynamics, developing ideas about how students might read their learning environment. Rachel asked us to consider semiotically some of the other features of her classroom environment. On one wall she pointed to a poster that she had placed in the center of the blackboard. The poster showed a diagrammatic representation of aspen parklands, an ecosystem that existed in the local community. Here, students in the class had been encouraged to post some of their own ideas about the kinds of animals, plants, and features of the landscape that they were familiar with. "I think that there might be a different message in what we are doing here," she said, "about how learning proceeds and what is valued. These posters respect students' views, encouraging them to express their ideas. I think this says that I, their teacher, value their ideas. I really want to develop more of these kinds of messages. Perhaps I can use photographs. I need new ways to think about how to do that." Casey added, "Textbooks have strong messages to consider also. When I was in school, it was always pictures only of boys doing the activities. Now the message in photos is that girls and students from a variety of cultural backgrounds can participate."

Together we had considered a range of sources of semiotic messages: (a) the architectural messages contained in buildings and classrooms, (b) some of the social

and behavioral messages of classroom interactions and rituals, and (c) text and curriculum messages. We talked about how cultural, school, and district policy messages are embedded in the symbol systems that students are exposed to and how they have a deep impact on their learning.

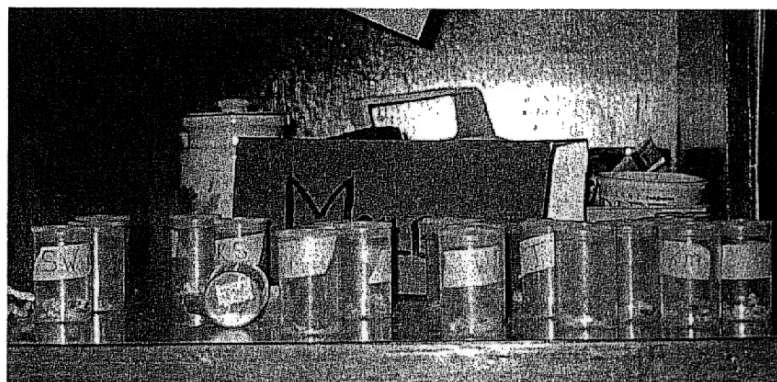
Continuing the Reading of Signs and Symbols

The original research project was designed to explore novice teachers' understandings of semiotics in school learning. Rachel's comments and involvement greatly enhanced our conversations, and now Rachel expressed an interest in going further with this thinking. Rachel said that she looks differently at classroom learning now and questions whether the messages she intends to send are actually being sent. Armed with a new approach to creating learning environments, Rachel hopes to build positive sign systems and to responsibly disrupt some of the powerful messages that may permeate learning that she does not intend to promote. Rachel comments that she wants to be more aware of the messages that are sent to students about science learning, not only those that she sends directly but also those that are sent through school policies, culturally embedded values, and other means. She is currently engaged in reflection on ways that she can use this information to "disrupt" her own practice, not only to become aware of students' readings of the classroom environment but also to help students also become aware of and improve the ways they use symbol and sign systems as they learn science.

Questions for Reflection and Discussion

1. What messages do you recall from your own school science learning experiences?
2. The picture below is from a class collection of mealworm vials from a study of life cycles (Figure 5.2). The vials have been placed on a shelf at that back of the classroom. What might be some of the messages that students or others entering the room might read about science study in this classroom? How might the display be enhanced to create powerful positive images of science learning?

FIGURE 5.2 Students' mealworm container display.



3. Examine carefully your school district's science program of studies or curriculum documents. What messages about science learning do you find embodied in these documents?
4. The sign and symbol systems we create function as messages that speak to students about the nature of science and about how science learning proceeds. Schools are not only places where the values and beliefs of one's culture are transmitted. They are also places where students learn the signs and symbols of their culture and send messages of their own. What are some of the signs and symbols that students learn to use?

Resources to Consider

Fisher, D., Henderson, D., & Fraser, B. (1997). Laboratory environments and student outcomes in senior high school biology. *The American Biology Teacher*, 59, 214-219.

This article provides background information about research on science classroom environments and reports on one study of student perceptions of the laboratory classroom learning environment. The findings indicate that students' attitudes and achievement are affected by their perceptions of the classroom laboratory environment. The *Science Laboratory Environment Inventory* (SLEI) is present in its entirety in an appendix following the report.

Gerlovich, J. A., & Parsa, R. (2002). Surveying: NSTA analyzes safety in the classroom. *The Science Teacher*, 69(7), 52-55.

The article reports the results of a recent national survey of National Science Teacher Association members. Questions on the survey asked about science teaching facilities, availability of science safety equipment, and teachers' uses of safety procedures. The results may help teachers evaluate their own teaching practices and understandings about science classroom safety.

Shapiro, B., & Kirby, D. (1998). A semiotic reading of the messages of science learning in a school science learning environment. *Journal of Science Teacher Education*, 9, 221-240.

Bonnie Shapiro and David Kirby discuss the variety of semiotic messages that students receive about the culture of science in their science classes. A significant feature of the article is a list of the types of messages in the science learning environment, including architectural messages, text and curriculum messages, social and behavioral messages, and messages associated with school and district policies.

Steinberg, S. R., & Kincheloe, J. L. (1998). *Students as researchers: Creating classrooms that matter*. London: Falmer Press.

This book emphasizes the development of student-centered learning environments that actively engage students in creating curriculum and creating understandings.

The Laboratory Safety Institute [On-line]. Available: <http://www.labsafety.org>

Founded in 1978 by Dr. James Kaufman, the Laboratory Safety Institute provides safety information and training for teachers. This Web site contains information about the