

Talking about Science: An Interpretation of the Effects of Teacher Talk in a High School Science Classroom

Elizabeth B. Moje

Department of Educational Studies, The University of Utah, Salt Lake City, Utah 84112

Abstract

This paper builds on research in science education, secondary education, and sociolinguistics by arguing that high school classrooms can be considered speech communities in which language may be selectively used and imposed on students as a means of fostering academic speech community identification. To demonstrate the ways in which a high school teacher's language use may encourage subject area identification, the results of an interactionist analysis of data from a 2-year ethnographic study of one high school chemistry classroom are presented. Findings indicate that this teacher's uses of language fell into three related categories. These uses of language served to foster identification with the academic speech community of science. As a result of the teacher's talk about science according to these three patterns, students developed or reinforced particular views of science. In addition, talking about science in ways that fostered identity with the discipline promoted the teacher as expert and built classroom solidarity or community. These results are discussed in light of sociolinguistic research on classroom competence and of the assertions of science educators regarding social and ideologic implications of language use in science instruction.

Research on linguistic variation among members of speech communities and networks has demonstrated the importance of language as a means of establishing and controlling community identification and solidarity (Brown & Gilman, 1960; Hymes, 1974; Labov, 1972; Milroy, 1987). Although research on linguistic variation is generally investigated in broad community settings such as cities or countries, sociolinguistic research can be conducted in smaller speech communities or social networks, including school classrooms. Gumperz (1971) argued that any group that demonstrates linguistic variation connected to the group's social structure can be considered a speech community. Further, Milroy's (1987) definition of a uniplex social network provides a useful way of viewing the classroom; in a uniplex network, individuals who may be members of various speech communities come together for a single purpose. As members of the network, individuals are connected to each other by the network's specific purpose, and they must learn to control the speech repertoire or register (Halliday, McIntosh, & Stevens, 1964; Hudson, 1980) necessary to interact successfully. Using these definitions, many sociolinguists have investigated language use and communicative competence—that is, how teachers and children negotiate appropriate repertoires or registers—in school classrooms (e.g., Cazden, John, & Hymes, 1972; Green & Wallat, 1981; Gumperz, 1977; Mehan, 1979; Sinclair & Coulthard, 1975; Wilkinson, 1982).

In a related vein, educational researchers have investigated the strength of secondary-level academic disciplines and the loyalties teachers maintain toward subject matter affiliations (Goodson, 1983; Johnson, 1990; Reid, 1984). The results of these predominantly qualitative studies demonstrate that secondary school teachers adopt particular pedagogical stances to promote positive images of their particular academic speech communities by fostering identification and solidarity among their students in a variety of ways.

Lemke (1983, 1987, 1990) brought these sociolinguistic and educational research focuses together in his sociolinguistic analysis of the use of language in middle and secondary school classrooms. Lemke illustrated how the complex meanings that students learn in secondary science are controlled by the structures and functions of language interactions. In addition, he argued that teacher motivations and ideologic foundations of science and society impact the use and effect of language in the science classrooms he observed.

In this article, I build on research in sociolinguistics, education, and science education by arguing that high school classrooms can be considered speech communities in which language may be selectively used and imposed on students as a means of fostering speech community identification. To demonstrate the ways in which a high school teacher's language use may encourage subject area identification, results of a sociolinguistic analysis of data from an ethnographic study of one high school chemistry classroom are presented. Although this research is grounded in Lemke's multiple analyses of the ways teacher and students *talk science* and talk about science in secondary classrooms, this study focuses on the effects of *talking about science*. That is, Lemke analyzed the ways the teacher and students used science words and concepts to communicate with one another, whereas I concentrated on how and why the teacher talked about science and what effects this talk had on the classroom culture and the meanings students made about science and science learning. The results of this study are discussed in light of sociolinguistic research in classroom communicative competence. Further, the social and ideologic implications of such language use for the educational success of students are considered.

Fostering Identity in the Classroom Community

Sociolinguistic research in a variety of speech communities or networks has illustrated the impact that language use may have on individuals. However, it has also been suggested that individuals have a fair amount of control over their ability to use language for specific purposes and to affect others. For example, in his 1961 to 1963 study of language use among residents of Martha's Vineyard, Labov (1972) reported that the residents varied their pronunciation of certain vowel pairs depending on their desire to be affiliated with the island. Milroy and Milroy (1985) also attested to the remarkable ability of speakers in Belfast to develop and maintain phonologic innovations depending on social network affiliation. Individuals have also been known to modify grammatic constructions, such as pronoun use, to maintain solidarity or to offend other community members (Brown & Gilman, 1960). Similarly, Fairclough (1989) illustrated that pronoun and other linguistic variations are often used purposefully in the media and in political arenas to engender solidarity or to connote power relationships.

It is clear that language use is, to some extent, a matter of choice and can be used by individuals for purposes of identification. In light of what is known about how language is used in broader speech communities and networks, it follows that language use in classroom communities could be equally controlled, and may also serve to maintain classroom identity and solidarity. In other words, classrooms represent communities or networks made up of individuals from varying speech communities. Secondary teachers, who often represent one particular

academic speech community, may use language in ways that allow them to maintain their identity with that community. Consequently, students who strive to be successful in school will likely adopt the teacher's language patterns to become a part of the classroom community. It is possible, however, that those students who, for a variety of reasons, do not seek to participate actively in the dominant school culture may resist or reject the teacher's language patterns and become alienated from the classroom community, choosing instead to maintain solidarity with other social or cultural groups (cf. Cazden, 1985; McDermott, 1985).

Nevertheless, it is reasonable to assert that secondary school teachers, with their primary focus on subject matter learning, may view themselves as having a greater need than elementary school teachers to use language as a means of promoting identity and solidarity among students. Whereas the elementary school teacher attempts to guide language use to promote language learning and to maintain certain culturally accepted social norms (Mehan, 1979), the secondary school teacher faces the challenge of engaging students in the study of subject matter terminology and concepts at advanced levels. The advanced and often abstract nature of secondary subject learning may make the terminology and concepts appear new, foreign, and bewildering to students (Campbell, 1986; Durkin, Crowther, Shire, Riem, & Nash, 1985).

Furthermore, it can be argued that it is crucial for secondary students to learn to talk in the language of subject matter, or register, as a way of increasing their potential for understanding the conceptual themes of the subject matter. Lemke's (1990) thematic analysis of the language used by teachers and students in various secondary science classrooms illustrated that talking science involves more than understanding definitions behind scientific terms. Specifically, Lemke pointed to the unique ways that scientists and teachers of science use terms in particular relationship to one another, thus building conceptual themes.

Talking the language of an academic speech community may serve to promote conceptual understanding. However, *talking about* that speech community may foster identification and solidarity with the subject matter among students. Studies of high school settings demonstrate that teachers have vested interests in promoting students' identification with curricular subject areas because teachers see a need to maintain or increase the perceived value of their work (e.g., Goodson, 1984). Motivations behind teachers' control of classroom interactions range from teachers' territorial disputes over status, materials, and resources (Goodson, 1983) to attempts to maintain a subject's valued status in the curriculum (Reid, 1984). In an investigation of subject matter loyalties, Johnson (1990) described these types of competitive attitudes that teachers across 34 schools exhibited toward academic disciplines, illustrating that certain disciplines were perceived as more prestigious than others. Moreover, Measor (1984) analyzed the opinions *students* hold and asserted that students valued certain classes more, and that their beliefs about subject matter corresponded to their teachers' beliefs about the importance of subject matter.

In addition to holding and promoting loyalties to subject matter, secondary teachers more often approach their teaching guided by discipline-based values and philosophies that dramatically influence all decisions they make about subject matter and pedagogy (Gudmundsdottir, 1990; Shulman, 1987). While investigating the influence of subject matter knowledge in the discipline of science, Brickhouse (1990) illustrated how science teachers' beliefs about the nature of science influenced their classroom practice. Lantz and Kass (1987) also investigated the relationship between the influence of beliefs and knowledge of subject matter among science teachers, and demonstrated that teachers' beliefs about science—their "functional paradigms"—influence science teachers' use of curriculum materials. In a similar study, Cronin-Jones (1991) found a relationship between teachers' belief systems and their implementation of various curricular innovations.

Although these loyalties, subject matter orientations, and influences on curriculum have been identified, little research has been conducted in secondary science classrooms to examine the ways a teacher might use language to promote identification with the subject matter among students. Studies on the effect of language use and its effects in science classrooms include Zeidler and Lederman's research that demonstrated that the everyday language used by science teachers affected the way students conceived of the nature of science along two paradigms: a realist or an instrumental view of science knowledge and practice (1987). In addition, Lemke examined how language is used to construct themes and how certain uses of language may contribute to establishing an ideology of science as authority (1987, 1990). These uses and purposes of language variation have also been examined in the *written* text of various disciplines (cf. Banks, 1991; Crookes, 1986; Myers, 1989); but little is known about the motivations behind linguistic variation in secondary science classrooms, nor has the impact of such variation on the nature of the classroom culture or students' beliefs and actions been investigated.

The research represented in this article seeks to understand how language is used by a teacher in a secondary science classroom and to discuss implications of such uses for the meanings constructed by teachers and students as they use language in their science classrooms interactions. The following case study provides an example of the ways in which a teacher *talks about* her discipline, chemistry. The interpretations made from this case study cannot be generalized to all high school classrooms, but the analysis is included to exemplify the potential for impact on student learning and behavior through language.

Talking About Science: A Case Study

Theoretical Framework

The theoretical framework that guided the data collection and analysis in this study was symbolic interactionism. Symbolic interactionism is based on the assumption that knowledge and meanings are negotiated by individuals through their interactions with one another (Blumer, 1969; Czyzewski, 1982). In particular, individuals give meaning to particular symbols, including other individuals, texts, and words, and they act based on the meanings they construct about those symbols as they interact in particular situations. The interactionist framework was informed and extended by Lemke's (1987, 1989, 1990) social semiotic perspective. Lemke also described language and literacy as a meaning-making process, but the semiotic perspective suggests that as individuals interact they construct "systems of meaning" that are defined by and define particular contexts (1990, p. 185). Lemke (1990) further asserted that in science classrooms, certain systems of meaning, or discourses (Gee, 1990), are privileged and can be used to promote the ideology of science as authority. Such assertions about the power of language in science classrooms provided an additional theoretical grounding for this analysis because these assertions make explicit the questions of power that are implicit in the meaning negotiations posited by a symbolic interactionist framework.

Data Collection Procedures

A sociolinguistic perspective requires a careful attention to the details of language use; therefore, every effort was made to record language interactions verbatim. For this analysis, then, the primary data sources were transcriptions from audiotapes of classroom lessons and formal interviews. Field notes and informal interviews served as a secondary, or supporting, data source for this analysis. The primary lesson data for this case study are derived from a

3-month period in the midst of a 2-year ethnography of a high school chemistry classroom. These 3 months corresponded to the beginning of a new academic year. I chose to collect these data during the first 3 months of the academic year because I wanted to learn how the teacher talked about science in her introductions to the discipline. I also wanted to investigate how students thought about and talked about science as they became members of this classroom culture. Because I also wanted to study the effects that such language use might have on the meanings students made about science and science learning, I also used field note data collected over the course of one academic year.

Audiotapes from the 3 months of classroom transcriptions were reviewed in full and sections were transcribed based on daily field note markings. Such a process yielded the transcription of approximately one half of all classroom interactions during the 3-month period. Audiotapes from 13 interviews (7 teacher interviews; 6 interviews of 3 students) conducted over the entire study were completely transcribed.

Three student key informants were interviewed individually on two separate occasions. These key informants were chosen on the basis of their gender, the interest and participation they exhibited during classroom activities, their levels of progress, and their willingness to speak with the interviewer. Two key informants were male; one of them demonstrated average levels of interest and participation and above-average progress, whereas a 2nd key informant was quite interested and participated actively, but his progress was average. The 3rd student—a female—exhibited low interest and low participation, but well above-average progress. All 3 students expressed a willingness to be interviewed.

The use of multiple data sources and multiple interviews with both teacher and students provided triangulation across data sources and informants, helping to reduce potential bias and subjectivity of researcher, teacher, and students involved in the study (Patton, 1990). In addition, findings of the analysis were shared with the teacher and key informants as a way of gaining feedback throughout the research process. The teacher participant also read the final draft of this article.

Data Analysis Procedures

Data were analyzed using constant comparative analysis procedures (Glaser & Strauss, 1967), which required daily reading of classroom and interview transcripts and field notes to determine emerging language patterns. During the process of open coding (Strauss, 1987), I constructed theoretical memos (Strauss, 1987; Strauss & Corbin, 1990; Wolcott, 1990) that allowed me to examine emerging patterns. These initial patterns guided further data collection and analysis, thus informing and determining the types of interview questions answered. For example, based on the analysis of initial classroom observations and audiotape transcripts, I interviewed the teacher to document her purposes for using language in particular ways. In the processes of axial and selective coding (Strauss, 1987), I used key linkage charts (Erickson, 1986) to substantiate and document the links between actions and events that occurred in the classroom. Such a procedure allowed me to test categories and assertions as the study progressed.

Participant Background and Roles

The setting for this study was a 1st-year chemistry class at Taft High School, which is located in a midsize town. The town's major employers include small industry, agricultural settings, and a university. The school population—both students and faculty—is composed

primarily of Caucasians from middle-class backgrounds. Because the overall study focused on literacy and language interactions, this setting was chosen on the basis of reports from the teacher that she used particular literacy and language strategies. In addition, the teacher's reputation as exemplary led me to choose this site. All individuals and places described in the reporting of results are represented by pseudonyms.

At Taft High School, Chemistry is a class normally taken by sophomores or juniors who are in a college preparatory program. The 2nd-hour chemistry class represented in this study was composed of 22 students: 8 girls and 14 boys. The students held varying science backgrounds; however, most had fulfilled some science requirements by having previously taken either general science or biology. The 2nd-hour section represented one of two basic Chemistry sections, as opposed to two other sections at the high school that were labeled Honors Chemistry. These sections were reserved for students who had completed mathematics courses considered necessary by the science department faculty at Taft for accelerated presentation of material.

At the time of this study, the chemistry teacher was a 20-year veteran, in her 6th full year of teaching at Taft High School. Like her students, the teacher was of Caucasian ancestry and was from a working-middle-class background. Having been educated as a chemistry and mathematics teacher, her primary areas of responsibility and interest were chemistry, mathematics, and science research. She identified strongly with the scientific community in the area and frequently used resources and contacts at the local university and at chemical industries in town. This teacher belonged to professional science and teaching organizations, and worked closely with both the chemistry education and chemistry departments at the local university. The teacher conducted a variety of research projects, including both quantitative science research and quantitative and qualitative science education research. The teacher described her objectives for chemistry instruction as the development of "scientific literacy":

I want them to be literate in chemistry. That's what my goal is. . . . Because that's what their lives are—chemistry. And I hope to see how they communicate their ideas . . . critical thinking kinds of things. . . . Critical analysis of what they do. More questioning.
[Teacher interview, February 11, 1992]

One aspect of the teacher's commitment to scientific literacy thus revolved around the communication of ideas and concepts in science. To this teacher, such communication required an ability to recognize, define, and discuss critical terms, concepts, and issues in science. These goals and objectives were in line with the teacher's philosophy of science as organization: "It [organization] kind of mirrors what science is. Science is organization. It's kind of a thread that goes through" [Teacher interview, October 24, 1991].

Before turning to the data presentation and interpretation of this teacher's talk about science, it is important to emphasize the interpretive nature of this study (cf. Peshkin, 1993). The purpose of the study was to understand how and why language was used in particular ways in this classroom. In the Results, then, I present and interpret data that illustrate how language was used, as well as data that illustrate the teacher's and several students' perspectives on why language was used. In a later section of the article, I discuss implications of and questions about these uses in terms of students' communicative competence and their developing views of science and science learning.

Results and Discussion

As a result of an analysis of the language used in this chemistry classroom and of interview data gleaned from teacher and students, I found that the teacher's talk about science, scientists,

And ways of knowing in science fell into 3 interrelated categories that reflected certain patterns of teacher talk. As I investigated these different patterns of talk about science, I interpreted purposes behind the teacher's talk. These ways of talking about science for particular purposes had important effects on the nature of the classroom culture and on students' beliefs and actions in the chemistry classroom.

First, as I observed and analyzed the classroom interactions during the first 3 months of the semester, I noted a pattern in the way the teacher talked about language and communication in science: She consistently referred to science as a discipline that required organization, accuracy, and precision. In particular, she believed that communication in science required accuracy and precision. Thus, she felt that she should make students aware of this aspect of language in science, and require that the students be precise in their use of this language. By emphasizing accurate and precise language, the teacher felt that she had empowered her students by teaching them to communicate with the speech community of scientists. The teacher also believed that using language in this way would help students understand the conceptual relationships and themes that underpin scientific knowledge and belief systems. She believed that such language use prepared the students to talk science (Lemke, 1990), because to talk science, students would have to understand that the language of science was unique, and they would have to be familiar with various terms to use them. This use of language led students to focus on terminology and procedures and to rely heavily on the text for verbatim responses that would reflect the accuracy and precision required by the teacher. In many cases, students did increase their accurate use of terms and ideas over the course of the year. However, it was unclear whether their uses of terms in the way modeled by the teacher led to an understanding of themes that undergird science concepts.

A second pattern that emerged from my analysis of the data was that the teacher talked about science in a way that distinguished science from other disciplines. She talked about science in this way to help make students aware of the unique nature of science language and concepts and to promote a certain sense of uniqueness and solidarity among students in the chemistry class as a community of science learners. Students acknowledged the teachers' emphasis on the unique nature of science in their many comments about the difficulty of chemistry, its theoretical nature, and its importance in their lives and in the world.

Third, the teacher used language such as personal pronouns in a way that identified her with the science community. She also used personal pronouns to refer to students as members of the science community and the classroom community. By using these linguistic devices the teacher encouraged students to identify with both the science and classroom communities. As a result of this identification and solidarity, students cooperated and worked with the teacher, lessening the need for overt control on her part.

Although separated for the purpose of analysis and explanation, these three patterns, or categories, of talk about science in this classroom should not be considered as distinct. The categories overlap and support each other in important ways. The categories, and their relationships to one another and to the effects on the classroom culture and the meanings students made about science, are represented in the key linkage chart displayed in Table 1. In the following sections, I provide data and analyses that illustrate these three categories of talk and the effects that this talk had in the classroom.

Pattern 1: Accuracy and Precision in Science Language

The teacher modeled and emphasized accurate and precise language in the chemistry classroom for two reasons. First, she believed that effective communication in science required using language carefully. She stressed to students that if they hoped to communicate effectively

Table 1

PATTERNS OF TEACHER TALK	PURPOSES FOR TEACHER TALK	EFFECTS OF TALK ON STUDENTS
Using and emphasizing accuracy and precision in oral and written language	Developing communication skills that would empower students to converse with members of the field of science Developing conceptual understanding	Tuned to text for verbatim responses to ensure accuracy and precision Focused on terminology and procedures Developed or reinforced views of science as accurate, precise, and unchanging
Distinguishing science from other disciplines	Emphasizing unique nature of science as discipline to encourage extra effort in learning Fostering solidarity and loyalty to the discipline to help build sense of community	Developed or reinforced views of science as difficult, important, powerful, theoretical
Using inclusive personal pronouns	Identifying self with the field Encouraging students to identify with the field and with the class	Engendered cooperation as result of respect for teacher as authority Engendered cooperation as result of trust in teacher and commitment to community

in the science field, they must be careful with their use of language. Second, she felt that as students used the language of science, particularly focusing on terminology, they would become familiar with what might seem to be strange and unfamiliar terms. This familiarity and facility with terminology, she believed, would help students learn science concepts.

Learning to Communicate in the Language of Science. The teacher began the year by providing students with opportunities to talk science. As they talked, she evaluated their attempts by talking *about* science. For example, in one early lesson, the teacher was attempting to distinguish between observation and inference, which she believed were two key terms to understanding the scientific method. She performed a demonstration and asked each student to make an observation about the demonstration. After all 22 students had stated observations, which were recorded on the board by one student, the teacher asked them to evaluate the various observations for their accuracy. The teacher made the comment that observations had to be objective, and that no inferences should be included. She suggested that to avoid making inferences students could use certain words:

You can use words like 'approximately,' or 'about' to record what you have observed. You've got to be careful. It's picky, but that's science [September 1, 1992].
We have to be very careful about the units [i.e., millimeters, grams, etc.] in science. Scientists do experiments on medication and drugs that affect people's lives. If we didn't measure carefully or left off an important unit, someone could die. Science involves life or death [October 3, 1992].

By talking about science as "picky," or as requiring accuracy, the teacher made it clear to students that the types of phrases they would be reading and hearing would reflect an emphasis on accuracy and the scientific method. The teacher's language had an influence on the way students thought about the study of science because she impressed upon them the need for accuracy as a result of the importance of science.

When asked in an informal interview about her focus on precise and accurate scientific

language, the teacher explained that she believed the students needed to realize that these terms had very specific uses in scientific study and research. I shared with the teacher some of Lemke's (1990) concerns regarding the misconceptions students might gain about science as a value-neutral and authoritative discourse when language was used in certain ways. We talked about Lemke's concern that students would be subject to the authority of science if they believed that it was value-neutral. The teacher countered Lemke's assertion with one of her own: She believed that without instruction on the precise meanings of these words, students would be "disempowered because they wouldn't be able to speak the language of science" [March 1993]. As a result, she argued, students would be at the mercy of those who had the knowledge of language necessary to be members of the science discourse community. The teacher's definition of empowerment, then, revolved around helping students learn the skills and strategies she believed were necessary for them to become informed and empowered citizens.

Whether students were empowered to speak the language of science as a result of the teacher's focus on accuracy and precision is debatable. For example, on several occasions students opted to read verbatim from the class text in an attempt to offer precise terms of definitions, as in the following field note excerpt:

When we started to discuss the periodic table today, Ms. L. called on Alison to define "binary compound." Alison took several seconds to flip to the definition in her notebook [copied from the course text]. She read it verbatim from her notes. Ms. L. accepted the definition. Later, Ms. L. called on John to tell the rules for predicting molecular compounds. He hesitated, looking nervous. "Read them directly from your notes," Ms. L. instructed. John read the rules verbatim from his notes [October 8, 1992].

In this excerpt, Alison illustrated her awareness that the teacher would accept only the most accurate answer; consequently, she turned to her notes, drawn from the course text, to provide that answer. The teacher's validation of the answer and her later direction to John to read directly from his notes prompted students to continue to turn to text in subsequent discussions of terms and concepts. Thus, the teacher's focus on accuracy and precision, although intended to communicate to students the importance of such qualities in any scientific enterprise, also resulted in her students becoming dependent on the text as an authority for employing accurate and precise language.

Developing Conceptual Understanding. The teacher also hoped to develop students' understanding of science concepts by letting students know, on a regular basis, that the language of science was unique. For example, in the following excerpt, the teacher was reviewing formula writing:

Let's see if you remember how to write these formulas, and let's see if you can provide the reason as to why you're writing the formulas as you are. . . . I really need you to concentrate and make sure that you understand, because the problems you'll be dealing with in this unit . . . are written in words, and what you need to do is take the words and translate those words into the language of chemistry—chemical formulas. You need to do that [November 4, 1992].

The importance of language to this teacher is clear in her exhortation to students to learn the "language of chemistry." What some assume to be a simple one-to-one correspondence (words to symbols or formulas), this teacher clearly believed to be a unique "language." The teacher

believed that her emphasis on language, particularly terms and specialized vocabulary, helped develop students' understanding of the concepts by encouraging them to memorize the symbols of the new language and the ways the new language was arranged.

This chemistry teacher's understanding of the importance of language in the learning of science concepts and themes is supported by Lemke's assertion that "the language of each specialized field has its own unique semantic patterns, its own specific ways of making meaning" (1990, p. 1). Because she considered the language of science unique, the teacher often made statements as reflected in the following field note excerpt:

Lew said that graphs categorize ideas. Ms. L. said, "What's a better way to say what you mean?" He said, "to show the differences?" Ms. L. said, "You're on the right track, but there's an even better word. What might it be?" He said, "I have no idea." Sarah raised her hand and said, "Shows comparisons?" "Yes, it shows comparisons," said Ms. L., "but an even better word is relationships. It shows relationships between things. In science, we talk about relationships. We use certain words in science to mean specific things" [September 25, 1992].

By making this distinction at the word level, the teacher reiterated her idea that the language of chemistry was specialized. She also made clear to students her belief that reading and tearing apart the language of science was crucial because it would help them make sense of the new concepts. Her admonition to say just the right word let students know that understanding the language and concepts of science in this class would require a special commitment to careful listening, reading, and studying.

An excerpt from a lesson transcription (supplemented by field note observations) provides an example of how the teacher pointed out that the English language was made up of different registers, one of which was a scientific register:

Teacher: "Mark, what does the phrase 'derived unit' mean?"
 Mark: "I don't know. I don't even know what 'derived' means!"
 Teacher: "You don't even know what 'derived' means. Can anyone help him out? Tyler?"
 Tyler: "Something that comes from the base unit?"
 Teacher: "That's very good, Tyler. Where did you get that definition? [to the rest of the class] Do you see his book open to the back [glossary]?"
 Tyler: "It's not in the back."
 Teacher: "It's not in the back?! Well, how did you know the definition, then?"
 Tyler: [Shrugging] "I just know what 'derived' means."
 Teacher: "You just know what 'derived' means. Okay. Apparently 'derived' in English means the same as it does in scientific concepts" [September 16, 1992].

Not only did the teacher distinguish between *English* and *scientific concepts*, but she implied that English is a different language from science. It is unlikely that the teacher was unaware that the word *derived* meant the same in English as it did in science. What is clear from this example, then, is that the teacher was attempting to point out that some concepts in science may have similar meanings to common words in the English language, whereas others will not. Her last phrase, "Apparently 'derived' in English means the same . . ." was a way of signaling that students could not always expect to make one-to-one correspondences between scientific concepts and everyday concepts.

When asked in an interview what she identified as the objective of chemistry learning, the teacher explained that she wanted students to think critically, analyze results, and ask questions.

Moreover, she expressed the idea that a major aspect of learning chemistry involved learning to communicate:

You know, part of it is being able to communicate verbally. And I think we do a lot of that. I try to, I ask them lots of 'whys.' 'Why this? Why that?' So that it's a clear meaning to everybody else. . . . Sometimes [they need] to look for special meaning within the context because, in science, sometimes it's really hard when you have a lot of new terms to pick out, what does this mean? . . . That's what I want to do . . . getting them to see science as something that's organized and looking for patterns [September 11, 1992].

The teacher's comments reveal her belief that science represents a unique language system with terms that the students need to be able to express verbally. Her focus on picking out "new terms" of science highlights the importance she saw in learning terms to develop conceptual understanding. When the teacher had students explain their reasoning behind certain answers, her purpose was to make sure that students could verbalize the concepts. The teacher believed that facility with the language of science was crucial to developing a complete understanding of science. The teacher also expressed her goal of getting the students to see science in a particular way—as the organized search for patterns. To meet that goal, she talked about science in ways that emphasized organization, accuracy, and precision.

Interviews with key student informants illustrate the students' ideas about science and language. One key informant, Lew, stated that scientists didn't necessarily speak a different language, but they were "more educated and knew more big words" [September 30, 1992]. Lew's comment indicated that he believed that scientists were more educated because they could use and define big words that less educated people would not know. His statement also indicated that he assumed that entrance into the community of scientists could be attained by learning those big words.

Another student, Al, indicated that Chemistry was one of his most important classes. When asked why, Al replied,

Elements and compounds and mixtures and all that stuff is new. . . . It helps that she has us [take notes] on the reading because the notes make sure we know what it [the text] is saying. . . . It gets you familiar with the vocabulary [October 9, 1992].

In his statement, Al illustrated his belief that chemistry represented a unique and, for him, new way of speaking and thinking about the world. He added,

This class is one of the hardest I have. . . . With English you can get an idea of the story from someone in one or two sentences. . . . No one can explain to you what chemistry is all about in a sentence or two [October 9, 1992].

For Al, chemistry's concepts were hidden behind the many new and confusing terms and phrases with which he was confronted in the class. Because he found the language of science unique and difficult, it required intensive study strategies (note taking and vocabulary definitions) and more of his time.

Heather, the 3rd key informant, offered perhaps the most vivid interpretation of how science and language were related, when she commented that she saw chemistry as being

so perfect. . . . It all seems really logical. . . . Chemistry has just, like, one interpretation. That's all, like, what it says in black and white. That's the only meaning.

Heather saw chemistry as a unique organizational system that allowed for a single, and logical, meaning. Her statement, "that's all, like, what it says in black and white," reveals her belief that the words of chemistry reflected the meaning of chemistry with no interpretation, no debate, no discussion.

All 3 students felt that the vocabulary of chemistry was crucial and required a special effort to understand. They also added that, despite career goals ranging from medicine to business, they felt that Chemistry was one of their most important classes. For example, Al specifically stated that he wanted to "get an A in this class and Algebra II more than any other class."

In this respect, then, it seems that the students' beliefs about the uniqueness and importance of chemistry language and learning reflected some of the teacher's beliefs because they, too, viewed chemistry terminology as crucial to the discipline. In addition, the students' views of science and scientists seem to reflect the ideology of science against which Lemke (1987, 1990) cautioned. However, when asked if they felt the teacher's insistence that they use precise language made chemistry difficult to understand, both Lew and Heather responded that the teacher explained the ideas clearly and used "everyday words" to help them understand. Asked about the readability of the course textbook, Heather said that she felt she only had to read through the text once, and implied that it was easy for her to read. She explained that, "In the past I've had science books that use big terms. This one's more like common, everyday language" [October 16, 1992]. Although not all students concurred with Heather that the textbook was *easy* to read, students interviewed formally and informally felt that the teacher had helped them work through any difficult terms and specialized vocabulary they encountered in the class. Thus, although my observations of the teacher documented her emphasis on the importance of communicating scientific ideas in scientific terminology, the students felt that she made connections to common uses of language that helped them learn the meanings of unique science terms. The students believed that the teacher helped them break through the big words of science.

Furthermore, although in initial interviews Heather expressed the idea that science was a unitary construct with perfectly logical answers and ideas, later in the year she seemed to modify that belief. In an interview that followed a unit on nuclear chemistry (March 10, 1993), Heather stated that Chemistry class made her "feel baffled." She explained that she was baffled by the realization that "there was just so much out there that we don't even know about yet. This is just the tip of the iceberg." In this statement, Heather reflected on the idea that she and the other students still had a great deal to learn about science concepts that could not be revealed in one class. Although such a statement indicates that Heather was aware of the incomplete nature of what she was learning about chemistry, it also implies that she believed that there existed a body of knowledge still to be learned. However, in a later interview, when I asked Heather about applications of chemistry to society, Heather suggested that perhaps science seemed to make too much sense:

H: It's like the whole idea of chemistry and everything, and the periodic table and everything like that, it all really makes sense and scientists can use that to find cures for stuff, but it's all based on just a theory, so I don't know.

I: It sounds like it bothers you that it's based on "just a theory."

H: Yeah, yeah it does.

I: Why?

H: Because, I don't know, I wish that they knew for sure. . . . Because it makes sense, but somehow it makes sense too well. It's too good to be true or something. I'm just a doubting Thomas or something [June 7, 1993]

Heather maintained that science had fewer hidden meanings than literature or philosophy, but her interview response indicated that she was beginning to modify her notions of the completeness or authoritative nature of science. At the same time, this response reveals that Heather had been presented with a picture of science as complete. She had not been exposed to the questions and conflicts that accompany scientific theory generation and testing. Moreover, Heather represents 1 of 22 students in the classroom who openly questioned the authority and completeness of science. In fact, other students, like Tyler, questioned instances in which their work deviated from finding exact answers. Such questions indicated a belief in the authority of science, as reflected in this field note excerpt drawn from the end of the first semester of the chemistry class:

Today Ms. L. raised the topic of theoretical yield versus actual yield in the process of balancing equations. Some students were confused when the example equation didn't balance. Ms. L. explained that previously they had talked about theories of chemical reactions, but that in reality equations didn't necessarily balance. Tyler stayed after class to challenge Ms. L. He argued that there had to be a way to balance the equation because "it was chemistry, it had to balance." Ms. L. again explained the difference between theoretical and actual yield. Tyler asked, "Then why do you teach us this if it's wrong?" Ms. L. hastened to correct Tyler, "It's not wrong. You're seeing the difference between the ideal and the real situations in chemistry" [January 7, 1993].

Although the teacher was attempting to make a distinction between the "ideal and real situations in chemistry," her emphasis on accuracy and precision throughout the first half of the year had an obvious impact on Tyler's thinking. He was frustrated by the possibility of something inexact in chemistry, and even accused the teacher of teaching them ideas that were wrong.

Pattern 2: Distinguishing Between Science and Other Disciplines

Another way in which the teacher encouraged identification with the scientific community and chemistry class, in particular, was to compare science to other subjects the students encountered. The teacher did this in an attempt to distinguish and set science apart from both other school subjects and everyday events. In the following excerpt from field notes, the teacher was explaining scientific graphing:

As Ms. L. talked about graphing, she compared it to graphing in math. She asked them [the students] how many people were doing graphing in math class. She said, "We're going to take the graphing that you do in math, and we'll show you how to do them just a little bit differently in science. In science, you deal with quantities so we have to see how you put quantities on the graph, rather than just numbers like you do in math." [10-14-92]

The teacher's careful delineation between the type of graphing done in mathematics, as opposed to chemistry, illustrates the important differences she sees in the languages of the two fields.

In a different instance, a student had worked a problem correctly in a demonstration for the class, but had written the final answer incorrectly. The teacher commented to the class that on a test she would have given the student virtually full credit because she believed that it was more important to be sure that the process has been done correctly. "In math class," she said, "he might not get any points. But in science we are concerned about the process" [November 6, 1992]. Again, and perhaps more forcefully, the teacher distinguished between the two disci-

plines. The ways in which she talked about science and math in these examples imply a belief that scientists are concerned with application, whereas mathematicians deal in abstractions. A comment like this served two purposes: It conveyed to students the teacher's belief that there are essential differences between the focus of science and the focus of mathematics, and it communicated the message that students in this class could expect to complete tasks in the same way scientists did, as members of the science classroom community. In addition, she communicated her interest to students in the process of their learning, an interest that students said they appreciated.

On another occasion, the teacher distinguished between the type of reading done in science and in other subject areas:

This is not a novel that you're reading, or a murder mystery, or a crime story. This is a science book. You have to hang tough and eventually you'll get it. You may have to read it once, twice, maybe 10 times to get the concepts that are talked about in these chapters [November 5, 1992].

From statements like this, the students learned that science learning—reading, thinking, and doing—was unique from other disciplines. In this case, the teacher implied that science reading was more difficult than other types of reading; science reading would require a special commitment. The teacher used statements such as these to encourage students to put extra effort into their science learning. Although she never explicitly denigrated other disciplines, she did emphasize the increased effort that science, and particularly chemistry, learning would require.

Thus, through such comments about the differences between science and other disciplines, the teacher created a feeling among students that science learning required a commitment over and above much of their other schoolwork. The necessity of extra effort was acknowledged by students: Although the 3 key informants admitted that they did not always read or study as carefully as they should, they reported that they considered reading the assigned text and keeping up with the homework assignments to be crucial to understanding the class discussion and activities. Lew, in particular, explained that he read and reread the science textbook until he understood what the text was saying. The teacher's talk alone did not build this belief among students; many students came to the chemistry class with the idea that the class would require more work than they had in other classes. Because they also believed that the class was very important to their future academic and career success (see earlier interview quotes), most students accepted the teacher's talk as valid.

Moreover, like the teacher, many students drew comparisons between the chemistry class and other disciplines. For example, Heather contrasted chemistry with English literature, talking about how English literature contained hidden meanings and deeper interpretations. In addition, both Heather and Lew made a comparison between creative writing and writing in science. Heather argued that writing in science did not involve opinions:

Well, my opinion doesn't matter that much. I mean, just because one person thinks this, they're not going to change everything that science is based on. . . . It's based on experiments and fact, and so it's not really opinions at all [March 10, 1993].

Like Heather, Lew suggested that writing in English class involved creativity, whereas writing in science class involved summarizing what others had said:

You're basically taking out main ideas of the paragraphs and just putting it in, just writing it in your own words. What they've said, you're just writing it. . . . In English [class],

you're using more of your head. You're not really necessarily summarizing, except for books or something. Usually in English you're using your own creativity and imagination [May 24, 1993].

These excerpts demonstrate the meanings students constructed about ways of knowing and learning in Chemistry class and English class. Moreover, these excerpts provide vivid examples of how the discourse promoted in the chemistry class served to support beliefs that the students brought to the classroom community of chemistry, and science, as being distinct from other disciplines and as relying on precision, accuracy, and organization.

Pattern 3: Personal Pronouns to Promote Solidarity

In addition to talking about science in ways that distinguished science from other disciplines, the teacher also talked about science in a way that built solidarity in the classroom community. First, the teacher established her own authority by identifying herself as a scientist. Then, as students became more familiar with scientific concepts, she promoted their identification with science issues and goals. The teacher accomplished this solidarity building by using personal pronouns, particularly the first person plural (e.g., we or our) to indicate inclusion in the community. In contrast to teachers who use language to soften a rebuke or an imperative (e.g., "We don't sit on tables in this classroom," [Yong-Lin, 1988]), this teacher fostered identification and solidarity through language by using first person plural pronouns in much the same way that members of cultural speech communities foster solidarity by varying the use of the two forms of the second person pronoun, you (Brown & Gilman, 1960).

Moreover, although the teacher's use of *we* to include herself among the community of scientists was consistent, it was not exclusive of students. As the semester progressed, she also used "we" to include her students as members of the science and classroom communities. It is important to note that the teacher did not use "we" every time she spoke to students, nor did she use the pronoun indiscriminately. Her use of "we" was not merely a way of talking to students, as opposed to peers. She did, however, use "we" consistently whenever she made statements about the nature of a scientific activity.

For example, when introducing significant digits, the teacher told students that these numbers could be called *significant figures*, as one of the other chemistry teachers referred to them, or *significant digits*, as she called them. She added, "You'll get used to the jargon and to our friendly use of these terms" [October 20, 1992]. Her expression of "our friendly use" indicates her alliance with other scientists and science teachers in a close and collegial relationship. Through her language, the teacher strove to make it clear to the students that she viewed herself as a professional who was familiar with the practice of science.

During another lesson, the teacher suggested a replacement term for words the students had used, commenting, "*Heat of fusion* is a very fancy term for *melting*. Scientists have their own language, and we create very fancy names for common words" [September 29, 1992]. In this excerpt the replacement of *scientists* with the pronoun, *we*, illustrates the teacher's view of her place in the scientific community.

At other times, the teacher used "we" in reference to the entire class of students. In essence, this let the students know that they, too, were members, albeit fledgling, of the scientific community. When discussing a separation technique, the teacher asked,

"How can I separate powdered glass from sugar?" Joni answered, "Well, I guess you could, like, strain it?" "What's a different word that we use in science instead of strain,"

the teacher asked. "Sift?" "Not strain, not sift, but . . ." the teacher trailed off, expectantly. "Filtered?" suggested Noreen. "Yes." [September 29, 1992]

This example illustrates the teacher's attempt to draw her students into a relationship with her as scientist. Instead of talking about how she and other scientists used numbers to achieve certain ends, the teacher included the students in the community. This inclusion is dramatically portrayed in a field-note recording of a comment to one student, Kari, later in the school year:

Ms. L. asked Kari what "actual yield" meant. Kari hesitated, then offered, "Isn't it like what the chemists get?" Ms. L. responded by saying, "Yes. It's what *you* get. You're a chemist, too. You'll get an actual yield in the lab." [January 11, 1993]

In essence, by bringing the students into the classroom scientific community, she signaled to them that they were all an integral part of the social and academic network of the classroom. Inviting students to become a part of this network not only encouraged them to tackle the concepts of science, but also promoted their cooperation with her. Indeed, students seemed to seek her acceptance and approval. In one interview, Lew commented:

She wants us to learn chemistry. She works really hard and she knows her stuff. She makes it easy for us to learn if we work hard, too. People don't try to get away with things in her class; they respect her. She deserves it, too. She's a good teacher [October 7, 1992].

In an informal interview, another student, Noreen, commented on a particular learning strategy and suggested that she engaged in the strategy because of her faith in the teacher:

It's the way you're supposed to do it for this class [Chemistry]. I know this is the best way for this material. . . . I trust Ms. L. [March 10, 1993]

These comments from students suggest that they felt a responsibility and commitment to the teacher that stemmed from the way she had interacted with them and made them a part of the classroom community. They trusted the teacher because they respected her expertise. They cooperated with her because they believed she wanted them to learn. This trust and respect stemmed in part from the way the teacher talked about science and about the students as members of the science and classroom community.

Conclusions and Implications

This teacher's talk about science fell into 3 patterns: (a) focusing on accuracy and precision, (b) distinguishing between science and other disciplines, and (c) using personal pronouns to promote her own authority as a science expert and to bring students into the classroom and science community. Through the teacher's talk, students began to hear about the importance of studying scientific concepts, and they were inducted into the community of science with an expert professional who encouraged them to participate cooperatively in the classroom science community. These functions of language in this classroom carry several implications for the educational success of these students.

First, students appeared to sense the importance of learning to talk science as a result of the teacher's emphasis on learning the various science terms and concepts. The teacher's belief that using the specialized language associated with science is supported by Perlwitz's (1993) assertions about "languaging" in mathematics. Perlwitz argues that students' use of language unique

to mathematics concepts propelled their progress toward developing conceptual understandings of mathematic phenomena to higher and higher levels. In turn, as their conceptual understanding increased, so did their ability to use language. Furthermore, as Lemke asserts, "the mastery of a specialized subject like science is in large part mastery of its specialized ways of using language" (1990, p. 21). Indeed, during the course of the larger study it appeared that many students began to use several new terms and phrases connected with chemistry concepts. The teacher's modeling of the use of technical vocabulary in particular contexts helped the students become communicatively competent in this chemistry class, a skill that was crucial for participating in class discussion and problem-solving sessions. However, it is not clear whether students always developed conceptual understandings as a result of their facility with the terminology and phraseology of chemistry. The evidence of students turning to the text to read verbatim definitions suggests that students may not have internalized the themes that connected the terms to concepts.

Second, the teacher's focus on accuracy and precision in using the language of science seemed to result in students' turning to the text or the teacher as authority, rather than trying to experiment with the language of science. Lemke (1987) points out the danger of emphasizing a scientific way of speaking, to the exclusion of a common, everyday way of speaking, suggesting that it is may be more useful to help students see how scientific terms developed from everyday ways of seeing and talking about the world. In this way, students are able to see science as an activity that has developed from people's need to understand the world. Many theorists have raised the concern that the promotion of a language of science may lead to the conception that there is one right way to talk about, and consequently to do, science (Lemke, 1990). Moreover, O'Loughlin (1992) points out that when we encourage students to engage in discourse that revolves around a "right answer" or a "right way," we risk the danger of conveying to students a belief that speech (and language) is a concrete and fixed entity, as opposed to sociocultural, multivoiced, and dynamic construction.

In fact, one student, Heather, initially expressed the belief that work in chemistry was guided by one meaning—a logical, perfect interpretation. Even later in the year, when Heather questioned the seeming perfection of science, it was clear that her questions remained unvoiced. Moreover, Heather's questions indicated that she had not been presented with the conflict and debate that often accompanies scientific theorizing and discovery. Thus, an insistence that scientific language be careful and precise may send the message that science knowledge is irrefutable, immovable, and representative of ultimate truths, promoting the ideology of the authority of science (Lemke, 1987). Such a message may lead students to believe that there is complete consensus on scientific issues among members of the scientific community, an idea that philosophers of science, and many scientists, argue is inaccurate (Kuhn, 1962; Laudan, 1984). Furthermore, the notion of science as authoritative and uniform may allow for science knowledge to be used as a means of controlling others (Kyle, 1991).

It is interesting to note that students in the chemistry classroom discussed in this article did not feel that the teacher or textbook focused on theoretical discourse. This was true despite the teacher's insistence on the use of specialized terms. The teacher's relaxed and approachable manner may have softened her demand for precision in a way that made students comfortable. Thus, researchers who focus on language use in classrooms must take care to investigate not only the frequency of types of language use, but also the *manner* in which language is used by teachers and students, and what effects a teacher's manner has on students' attitudes about science.

When asked about these issues, the teacher represented in this article explained that she used language in certain ways to help students become *more powerful* by having the scientific

language and background to discern issues of scientific importance in society. Much like the teachers represented in Delpit's (1988) essay, this teacher focused on helping students become successful in the "culture of power." Her attempts to foster students' facility with the language of science and their identity with the scientific community were geared toward breaking down the power fostered by others who have more knowledge of science than the average lay person. Understanding the teacher's humanistic definition of empowerment is crucial to understanding her uses of language that stressed vocabulary and terminology. Based on these insights, it is clear that as we research language use in classrooms, we must try to understand the emic, or insider, perspectives (Pike, 1990) of teachers and students over time.

Nevertheless, it is also important to question the outcome of such language use, regardless of the teacher's manner or intention behind such uses of language. Heather's changed view of chemistry at a later point in the year ("I'm just a doubting Thomas") suggests that the teacher's focus on precise language did not lead Heather to construct a view of science as a concrete and fixed entity. However, Heather may represent a discrepant case; the comments and actions of other students seem to suggest that the focus on precision, accuracy, and organization did serve to reinforce views of science as immutable, authoritative, and fixed.

A third implication of these results revolves around the teacher's use of language to build a classroom community and to bring students into the scientific speech community. The data illustrate that building solidarity through language challenged students in this science class and helped to achieve cooperation among students and between the students and teacher. These students worked diligently and seemed to respect the teacher as an expert in her field. All three of the key student informants expressed the desire to meet the teacher's expectations because she deserved their cooperation and respect. In essence, the teacher's talk about science allowed her a measure of control over both classroom management and content instruction, or, as Christie (1991) suggested, the teacher established *pedagogical* and *content registers*. The pedagogical register was the use of language that fostered identity and solidarity. The teacher's content register is represented by her insistence on using what she considered the most accurate and precise terms of science.

In the case of this classroom, the teacher's use of language that achieved identification and solidarity allowed her to avoid engaging in overt classroom management techniques. However, although the teacher did not find it necessary to admonish students or remind students to pay attention and participate, it can be argued that her use of language was, nevertheless, a controlling or hegemonic device. In essence, the teacher gained control by building community and allegiance to the community. Because students felt like they belonged ("You are a chemist"), they enjoyed the class, participated, and cooperated with her. As a result of this control through community building, however, the students rarely questioned the teacher. As one student suggested, she participated in particular activities because she "trusted Ms. L."

Questions for Further Research

Language is a powerful tool that can be used by individuals, consciously or unconsciously, to influence the thinking and behavior of others. In few speech communities or networks is the potential for control through language greater than in the classroom. If we view the secondary classroom as a social network in which the teacher is a representative of an academic speech community, and if we agree that individuals can manipulate their language patterns to conform to the group with which they identify, then we must acknowledge the potential for teachers to influence their students' language and thinking, both consciously and unconsciously.

The results of the study reported in this article cannot be generalized to all high school

classrooms; however, the results demonstrate the ways language can be used in pedagogical practice. Although not every teacher uses language in ways that foster identification with a discipline, the results of this study indicate the possibilities for such language use. For example, this teacher stressed the importance of scientific language because of her allegiance to and identification with the field of science. This pedagogical practice allowed her to concentrate more on teaching content material and less on classroom management, because she commanded respect and had built a classroom community. Other teachers may emphasize connections to more common language and encouraging students to incorporate everyday language in their scientific explanations. Despite the difference in focus on language, such practice also represents a pedagogy of discipline-based language use that illustrates the power of language in classrooms. In either case teachers are making decisions about how or if classroom community members (students) will develop the communicative competence necessary to succeed in their particular disciplines, classrooms, and settings outside school.

For example, exclusive language use could lead to breakdowns in communicative competence outside the classroom. According to Hymes (1979), communicative competence involves the capacity to acquire and use language appropriately in different social situations. If students are led to believe that the language of a discipline is fixed, they may struggle with communicating the concepts they have learned when engaged in different social networks. Fostering a sense of identity and solidarity within the classroom represented in this study seemed to enhance student cooperation and enjoyment of the subject matter. It could, however, lead students to reject other ways of thinking. They might view other subjects as less meaningful, or less important to their future lives and work, particularly when certain subjects are clearly viewed by students as having more status or prestige in the broader society (Measor, 1984). By promoting identification with one discipline area, teachers may send the message that other disciplines are not as precise, useful, or important (Lemke, 1987).

Moreover, some students may lack the communicative competence to employ the types of language urged on them by their teachers. Although this did not seem to be true for the majority of students in this classroom, perhaps because of academic prerequisites necessary for enrollment in the class or shared conceptions of science and learning, Gumperz asserted that "to the outsider . . . lack of communicative knowledge can serve as a barrier which impedes learning and can bar access to valued skills" (1982, p. 43). Studies in a variety of elementary school classrooms have examined the impact of differing communication channels at work between teachers and students, usually as a result of cultural differences between home and school speech communities (Gumperz, 1977; Heath, 1983; Philips, 1972). However, few studies have examined secondary settings, in which a teacher's exhortations to dig into text and take on the language of science may present difficulties for students. Moreover, research on language use and communicative competence in high school settings is complicated not only by social and cultural differences, but also by the values and ideologies embedded in academic speech communities. Thus, in a high school content classroom, it is important to ask what it means to be an outsider to the speech community.

First, the classroom science teacher is the only actual member of the science speech community, whereas students are novices at talking science. The burdens of communication in science may be heavy for such novices, especially if the students do not have extensive backgrounds in science. Concerns about speaking in a certain way or according to a particular discourse pattern may cause students to rely on text rather than to experiment with talking the discipline. Instead of practicing the language, students may feel compelled to rely on text or notes in an attempt to provide right answers.

Second, in this study, the values that led the teacher to believe that science talk involves

precision, accuracy, and organization stem from a discourse that has been traditionally dominated by white, middle-class males. Being an outsider in an academic speech community, then, can mean more than simply not being able to participate in the talk of the community; it may also involve being alienated or rejected by the talk of the community. Thus, the results of this study imply a potential for teachers to alienate students from further study in a particular discipline, simply as a result of certain ways of using language. Students may feel excluded from the academic community because they are unable to master the language or feel excluded by a language whose values they do not share. Or, students may rebel against the authority represented in the academic discourse of particular subject areas, thus refusing to participate in class activities. It is crucial that we investigate questions regarding how the shared cultural perspectives (white, working and middle class, college educated and college bound) between the teacher and her students influenced the students' willingness to engage in the language necessary to succeed in the classroom represented in this study. How would students from diverse social and cultural backgrounds have responded to the teacher's uses of language? How would students who held differing views of science as discovery or inquiry have interacted with this teacher based on her emphasis on accuracy, precision, and organization?

This study provides a backdrop for further research to explore these implications and questions. Such research could focus on classrooms in a variety of science disciplines to determine the extent to which science teachers identify with subject areas and purposefully attempt to influence students' language use. By contrast, further research could examine the differences in subject matter identification between teachers of various disciplines, in an attempt to understand how teachers are influenced by disciplinary knowledge, and whether language is used to meet pedagogical goals in different fields. A useful comparative study might include an investigation of how teachers and students in culturally diverse schools use language, focusing on how a teacher uses language and how students from a variety of backgrounds perceive and act on the ways language is used by teachers. Regardless of the approach taken, it is imperative that the uses of language in secondary classrooms be further investigated, with a focus on understanding and interpreting how and why teachers and students use language to talk about and learn content in various disciplines.

References

- Banks, D. (1991). Some observations concerning transitivity and modality in scientific writing. *Language in Society, 13*, 59–78.
- Blumer, H. (1969). *Symbolic interactionism: Perspective and method*. Berkeley, CA: University of California Press.
- Brickhouse, N.W. (1990). Teachers' beliefs about the nature of science and their relationship to classroom practice. *Journal of Teacher Education, 41*(3), 53–62.
- Brown, R., & Gilman, A. (1960). The pronouns of power and solidarity. In T. Sebeok (Ed.), *Style in language* (pp. 253–276). Cambridge: MIT Press.
- Campbell, D.R. (1986). Developing mathematical literacy in a bilingual classroom. In J. Cook-Gumperz (Ed.), *The social construction of literacy* (pp. 156–184). Cambridge, MA: Cambridge University Press.
- Cazden, C.B. (1985). Social context of learning to read. In H. Singer and R.B. Ruddell (Eds.), *Theoretical models and processes of reading* (3rd ed.) (pp. 595–610). Newark, DE: International Reading Association.
- Cazden, C.B., John, V.P., & Hymes, D. (Eds.). (1972). *Functions of language in the classroom*. New York: Teachers College Press.

- Christie, F. (1991). Pedagogical and content registers in a writing lesson. *Linguistics and Education*, 3, 203–224.
- Cronin-Jones, L.L. (1991). Science teacher beliefs and their influence on curriculum implementation: Two case studies. *Journal of Research in Science Teaching*, 28, 235–250.
- Crookes, G. (1986). Towards a validated analysis of scientific text structure. *Applied Linguistics*, 7, 57–69.
- Czyzewski, Marek (1982). The problem of identity in modern sociology of interaction. *Sociolinguistics Newsletter*, 13(2), 4–8.
- Delpit, L.D. (1988). The silenced dialogue: Pedagogy and power in educating other people's children. *Harvard Educational Review*, 58, 280–298.
- Durkin, K., Crowther, R., Shire, B., Riem, R., & Nash, P.R.G. (1985). Polysemy in mathematical and musical education. *Applied Linguistics*, 6, 147–161.
- Erickson, F. (1986). Qualitative methods in research on teaching. In M.C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 119–161). New York: MacMillan.
- Fairclough, N. (1989). *Language and power*. London: Longman.
- Gee, J.P. (1990). *Social linguistics and literacies: Ideology in discourses*. London: The Falmer Press.
- Glaser, B.G., & Strauss, A. (1967). *The discovery of grounded theory: Strategies for qualitative research*. New York: Aldine.
- Goodson, I. (1983). *School subjects and curriculum change*. London: Croon Helm.
- Goodson, I. (1984). Subjects for study: Towards a social history of curriculum. In I.F. Goodson & S.J. Ball (Eds.), *Defining the curriculum: Histories and ethnographies* (pp. 25–44). London: The Falmer Press.
- Green, J.L., & Wallat, C. (Eds.). (1981). *Multiple perspective analyses of classroom discourse*. Norwood, NJ: Ablex Publishing.
- Gudmundsdottir, S. (1990). Values in pedagogical content knowledge. *Journal of Teacher Education*, 41(3), 44–52.
- Gumperz, J.J. (1971). *Language in social groups*. Stanford: Stanford University Press.
- Gumperz, J.J. (1977). Conversational influence and classroom performance. In J. Green & C. Wallat (Eds.), *Ethnography and language in school settings* (pp. 3–23). Norwood, NJ: Ablex.
- Gumperz, J.J. (1982). *Discourse strategies*. Cambridge, MA: Cambridge University Press.
- Halliday, M.A.K., McIntosh, A., & Stevens, P. (1964). *The linguistic sciences and language teaching*. London: Longman.
- Heath, S.B. (1983). *Ways with words*. Cambridge, MA: Cambridge University Press.
- Hudson, R.A. (1980). *Sociolinguistics*. Cambridge, MA: Cambridge University Press.
- Hymes, D.H. (1974). *Foundations in sociolinguistics: An ethnographic approach*. Philadelphia: University of Pennsylvania Press.
- Hymes, D.H. (1979). On communicative competence. In V. Lee (Ed.), *Language development* (pp. 36–62). New York: Halsted Press.
- Johnson, S.M. (1990). The primacy and potential of high school departments. In M.W. McLaughlin, J.E. Talbert, & N. Bascia (Eds.), *The contexts of teaching in secondary schools: Teachers' realities* (pp. 167–184). New York: Teachers College Press.
- Kuhn, T.S. (1962). *The structure of scientific revolutions*. (2nd ed.). Chicago: University of Chicago Press.
- Kyle, W.C., Jr. (1991). The reform agenda and science education: Hegemonic control vs. counterhegemony. *Science Education*, 75, 403–411.
- Labov, W. (1972). *Sociolinguistic patterns*. Philadelphia: University of Pennsylvania Press.

- Lantz, O., & Kass, H. (1987). Chemistry teachers' functional paradigms. *Science Education*, 71, 117–134.
- Laudan, L. (1984). *Science and values*. Berkeley: University of California Press.
- Lemke, J.L. (1983). *Classroom communication of science*. Final Report to the U.S. National Science Foundation. (ERIC Document Reproduction Service No. ED 222 346)
- Lemke, J.L. (1987). Social semiotics and science education. *American Journal of Semiotics*, 5, 217–232.
- Lemke, J.L. (1989). Social semiotics: A new model for literacy education. In D. Bloome (Ed.), *Classrooms and literacy* (pp. 289–309). Norwood, NJ: Ablex Publishing Company.
- Lemke, J.L. (1990). *Talking science: Language, learning, and values*. Norwood, NJ: Ablex.
- McDermott, R.D. (1985). Achieving school failure: An anthropological approach to illiteracy and social stratification. In H. Singer and R.B. Ruddell (Eds.), *Theoretical models and processes of reading* (3rd ed.) (pp. 558–594). Newark, DE: International Reading Association.
- Measor, L. (1984). Pupil perceptions of subject status. In I. Goodson & S. Ball (Eds.), *Defining the curriculum: Histories and ethnographies* (pp. 201–217). London: The Falmer Press.
- Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge, MA: Harvard University Press.
- Milroy, J., & Milroy, L. (1985). Linguistic change, social network, and speaker innovation. *Journal of Linguistics*, 21, 339–384.
- Milroy, L. (1987). *Language and social networks* (2nd ed.). Oxford: Blackwell.
- Milroy, L., & Margrain, S. (1980). Vernacular language loyalty and social network. *Language in Society*, 9, 43–70.
- Myers, G. (1989). The pragmatics of politeness in scientific articles. *Applied Linguistics*, 10, 1–35.
- O'Loughlin, M. (1992). Rethinking science education: Beyond Piagetian constructivism toward a sociocultural model of teaching and learning. *Journal of Research of Science Teaching*, 29, 791–820.
- Patton, M.Q. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage.
- Perlwitz, M. (1993). *Analysis of the reflexivity between languaging and children's construction of concepts of ten*. Unpublished doctoral dissertation. Purdue University, West Lafayette, IN.
- Peshkin, A. (1993). The goodness of qualitative research. *Educational Researcher*, 17(7), 17–22.
- Philips, S.U. (1972). Participant structures and communicative competence: Warm Springs children in community and classroom. In C.B. Cazden, V.P. John, & D. Hymes (Eds.), *Functions of language in the classroom* (pp. 370–394). New York: Teachers College Press.
- Pike, K.L. (1990). On the emics and etics of Pike and Harris. In T.N. Headland, K.L. Pike, & M. Harris (Eds.), *Emics and etics: The insider/outsider debate* (pp. 28–47). Newbury Park, CA: Sage.
- Reid, W.A. (1984). Curricular topics as institutional categories: Implications for theory and research in the history and sociology of school subjects. In I. Goodson, & S. Ball (Eds.), *Defining the curriculum: Histories and ethnographies* (pp. 67–75). London: The Falmer Press.
- Shulman, L.S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, 57, 17–38.

Sinclair, J., & Coulthard, M. (1975). *Towards an analysis of discourses: The English used by teachers and pupils*. Oxford: Oxford University Press.

Strauss, A. (1987). *Qualitative analysis for social scientists*. Cambridge, MA: Cambridge University Press.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research*. Newbury Park: Sage.

Wilkinson, L.C. (1982). *Communicating in the classroom*. New York: Academic Press.

Wolcott, H.F. (1990). *Writing up qualitative research*. Newbury Park, CA: Sage.

Yong-Lin, Y. (1988). The English pronoun of address: A matter of self-compensation. *Sociolinguistics*, 17, 157–180.

Zeidler, D.L., & Lederman, N.G. (1987, April). *The effect of teachers' language on students' conceptions of the nature of science*. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Washington, DC.

Received September 23, 1993

First revision September 15, 1994

Second revision October 24, 1994

Accepted October 25, 1994



...



...

