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Elementary Teachers' Use of Language to Label and Interpret Science Concepts

Nicole J. Glen, Bridgewater State College
Sharon Dotger, Syracuse University

Abstract

This qualitative study examined how three teachers of upper elementary students used science vocabulary in their lessons. The data revealed that teachers used vocabulary to label science phenomena and interpret scientific concepts for students. The practice of labeling was used more extensively than interpreting. Teachers did not help their students understand why scientists use language in these two ways or how one informs the other. Implications for science educators include using inquiry to explicitly teach the purposes of scientific language in order to enhance elementary teachers' knowledge of how vocabulary can aid student understanding of science.

Many elementary teachers expect their students to learn science vocabulary, or the technical terms of science, in order to read about and understand scientific concepts. The field of science has a tremendous amount of vocabulary, and vocabulary and definitions are often given precedence in many science lessons (DeBoer, 2000; National Research Council [NRC], 1996). This may be in part because the technical terms in science texts create lexically dense reading (Halliday & Martin, 1993) because many specific scientific terms are packed into a sentence (Fang, 2005). Additionally, in K-12 science textbooks, not only are scientific terms a significant part of textbooks for all grades, but the average number of technical terms used in the textbooks tends to increase with grade level (Yager, 1983).

Many teachers are aware of the degree to which terminology is used in textbooks and see this as a reason to help students learn science vocabulary (Shymansky, Yore, & Good, 1991). Elementary teachers understand that increasing students' vocabulary knowledge has a significant impact on their comprehension of texts containing the learned vocabulary words (McKeown, Beck, Omanson, & Perfetti, 1983; Nagy & Herman, 1987; National Institute of Child Health and Human Development, 2000). Learning science vocabulary also helps students understand what science, as a discipline, is like. It allows students access to the values, ideas, and activities of science (Gee, 2004) because the creation and expression of scientific knowledge and theories is dependent upon language (Norris & Phillips, 2003). Language is "used by scientists to interpret, construct, describe, and present science claims and arguments" (Hand et al., 2003, p. 608). Students' knowledge of technical terms helps them gain access to scientific knowledge and written texts in order to enhance their understanding of scientific concepts. In addition, students' science vocabulary knowledge helps teachers know if they have successfully covered the required content for a curriculum and if students are prepared for what they may learn in the next grade level (Shymansky et al., 1991).

Thus, there are many reasons why teachers want their students to know what specific scientific terms mean, including the improvement of reading comprehension, understanding scientific concepts, and gauging learning. What is not known is how teachers are helping their students learn and use scientific language and what other purposes they might have for explicitly addressing scientific language in their classrooms. This is the rationale for the present study, which addresses two main questions: (1) How do elementary teachers use science vocabulary during instruction? and (2) What is their rationale for and expectations of students' science vocabulary learning?

Background

After analyzing features of language use in the scientific ideas from the 16th through 19th centuries, as well as current research about teachers' and students' beliefs about the nature of science, Sutton (1996) noted that language in science is used in two distinct ways. One way is as a "tool for trying out ideas, [and] for figuring out what is going on" (p. 5). This is "language as an interpretive system." It depicts scientists' use of metaphors, analogies, and descriptive, nontechnical language for describing their tentative claims about nature (see also Lemke, 1990). It is flexible, changes to meet the needs of scientists as they create explanations that they must convince others to consider, and is an invitation to others to share a particular view. Scientists' voices are usually present in the first person. When creating metaphors, scientists may take labels from other scientific fields and apply these labels to interpret nature and describe speculative ideas in their own field.

Language as an interpretive system is crucial to helping students develop conceptual knowledge in science. Norris and Phillips (2003) noted that "scientific discourse always attaches to and is dependent upon discourse that has gone before [it]" (p. 232). Scientists use scientific concepts that are well-established to help explain their new claims and allow others to interpret their claims. In this sense, conceptual science knowledge cannot be acquired by knowing isolated pieces of information; instead, students must understand how the information was originally interpreted and connected to other scientific knowledge. Knowing scientific concepts should include knowing "the process or likely process through which the statement was conceived, the degree of certainty that the field attaches to the statement, [and] the role in reasoning the statement plays in connection with other scientific statements" (p. 237).

Sutton (1996) explained that eventually scientists' claims become established, and agreed-upon knowledge and labels are assigned to them; this is "language as a labeling system." Language is not flexible at this point because specific words are used as labels for definite things. This type of language is used to transmit facts to others, and scientists' voices are generally absent. In textbooks and other written sources, facts are presented with a sense of "universal validity" (p. 10), with little reference to who first put the idea forward and how that person initially interpreted nature to make the claim. Language as a labeling system is necessary to have a conversation about science, and it allows a speaker to provide unambiguous claims about what he or she is witnessing (Gee, 2004).

Sutton's (1996) framework for scientific language has been used by other researchers to discuss findings of studies that investigated students' and teachers' uses of language during science lessons. Wickman and Östman (2002) found that university students working in small groups used familiar words instead of scientific terms when discussing insect organs. The metaphors and analogies the students used represented language as an interpretive system and enabled them to construct relationships between what they already knew and the labels they would learn for

insect organs. Rowell and Ebbers (2004) noticed that the school district curriculum the teacher in their study used was geared toward language as a labeling system, despite the district's insistence that it was inquiry-oriented. Thus, the 6th-grade teacher situated herself as an authority of scientific terms in order to align her teaching with the district's curriculum and assessment expectations. She had difficulty facilitating students' construction of ideas or their generation and validation of scientific knowledge because of the curriculum's focus on labels. Finally, several researchers have found that when students are allowed to write about their science experiences using metaphors and analogies, or language as an interpretive system, it allows them to learn more about how the scientific discipline constructs knowledge and leads to their greater conceptual understanding of the technical terms and concepts in science (Prain, 2006; Prain & Hand, 1996; Rowell, 1997).

Sutton's (1996) theory of the two conceptions of language is a relevant framework for analyzing teachers' uses of vocabulary during science lessons. Using Sutton's theory we are able to contribute a new perspective to the small number of studies that examined uses of scientific language as a labeling and an interpretive system. This paper addresses the research questions described previously by examining how three elementary teachers used language as both a labeling and an interpretive system to increase their students' knowledge about general science concepts and specific science vocabulary.

Methods

This was a preliminary qualitative study of three upper elementary teachers conducted during the 2006-2007 academic year. Symbolic interaction was the methodological theory guiding this study. *Symbolic interaction* is the belief that people give meaning to experiences and things and act toward them accordingly (Blumer, 1969). Science vocabulary use is an aspect of education for which teachers will create their own meaning. For example, one teacher in this study defined science vocabulary use in terms of what she thought scientists must know in order to do their work. Other studies have suggested that teachers view vocabulary knowledge as a way for students to comprehend scientific reading (Fang, 2005; Nagy & Herman, 1987) or to further science understanding (Spencer & Guillaume, 2006). This study examined the meanings that teachers placed on the use of science vocabulary in their classrooms.

Participants

Carl (all teachers' names are pseudonyms) was a 4th-grade teacher in an urban school district in New York. He taught science for one hour every day; however, he alternated between teaching science and social studies throughout the year. Carl's students were required to take a New York State standardized science test during the spring of the academic year. Don was a 5th-grade teacher in the same school as Carl. Don taught science for 40 minutes every day and also alternated between teaching science and social studies throughout the year. The students in Carl and Don's school included 62% black students, 29% white students, and 9% other racial origin. Seventy percent of the students received free or reduced-price lunch. Trish was a 6th-grade teacher in an adjacent suburban school district in New York. Trish taught science for 40 minutes, three periods a day, all year long. The students in Trish's school included 80% white students, 10% black students, and 10% other racial origin. Fifteen percent of her students received free or reduced-price lunch. All of the teacher participants were volunteers who had been recruited from schools that worked closely with the teacher certification program in one of the researcher's institutions.

Procedures

Participant observations, semistructured interviews, and a small collection of artifacts were used to understand teachers' perspectives (Bogdan & Biklen, 2003) of the use of science vocabulary. An initial interview was conducted before any participant observations took place in order to learn more about the teachers' general pedagogical practices. Questions during this interview included the following: "If I were to walk into your class during one of your science lessons, what might I see you and the students doing?," "Where do you get the ideas from for your science lessons?," and "Tell me about some of the science units you've taught already this school year." Additional interviews were conducted, as needed, in order to ask follow-up questions in relation to observations, previous interviews, and teachers' perspectives about their science vocabulary use. Questions during these interviews included, "What do you expect of your students when they're learning the vocabulary words?," "What do you do to help students learn the vocabulary words?," and "How do you choose the vocabulary words that you use?" Carl was interviewed three times, Don two times, and Trish three times.

In addition to the interviews, Carl was observed twice, Don once (due to scheduling conflicts), and Trish three times. Observations lasted the length of the teachers' science lessons, and the dialogue of the teacher and students and an account of events were reconstructed in writing immediately after the lesson (Bogdan & Biklen, 2003). Several artifacts illustrative of pedagogical practices regarding science vocabulary were collected from each teacher. For example, Carl provided a weekly vocabulary worksheet and a worksheet where students had to create a bear habitat for a zoo. Don provided a worksheet and a list of resources that his students were using to choose and create a project about human bones and muscles. Trish provided two worksheets depicting science labs her students completed.

During and after the data collection process, the researchers collaborated to develop themes. The constant comparative method was used to create categories, to identify the characteristics of each, and to make connections among them (Glaser & Strauss, 1967). The categories were based on teachers' pedagogical practices and rationale for vocabulary use in their science lessons. Then we carefully examined Sutton's (1996) theory of the two conceptions of language and developed codes from our initial categories based on those that related to his theory. The codes developed during data analysis resulted in eight explicit ways that the teachers used vocabulary in their teaching. Four of these codes created by the researchers align with Sutton's idea of language as a labeling system; the other four codes align with Sutton's idea of language as an interpretive system. The findings presented below represent the codes that we developed.

Findings

Teachers' Uses of Language as a Labeling System

Sutton (1996) reported that teachers whose instruction is geared toward describing or reporting scientific facts are generally using language as a labeling system. These teachers expect students to know "one correct word for one correct thing" (p. 14) because there is an assumption that words have fixed meanings within a certain context. All of the teachers frequently used this type of language. Table 1 shows how often features of language as a labeling system were documented in observations, interviews, and artifacts during this study. The percentages in each column, provided to assist the reader with comparisons among teachers, show the distribution of

usage for each teacher and for each category of language as a labeling system. It is important to note that although we discuss the characteristics separately, they are very much interrelated. For example, during one lesson in Trish's classroom, the class was reading aloud from their textbook and learning how to recognize the names and pictures of different types of bacteria. This was categorized as both "labeling," because students were learning the labels for the bacteria pictures, and "text as authority," because the students and teacher did not question the textbook, look for other sources of information, or provide their own personal descriptions of the bacteria. Below, we present specific examples for the characteristics of language as a labeling system using codes that we placed on the data. These codes, while grounded in Sutton's framework, emerged from the analysis of all three teachers.

Table 1. Occurrences of Language as a Labeling System

Type of Occurrence	Carl	Don	Trish	Total
To label objects	23 (39%)	11 (48%)	36 (33%)	70 (36%)
To present fixed definitions	9 (15%)	10 (44%)	23 (21%)	42 (22%)
To learn more science	11 (19%)	1 (4%)	22 (20%)	34 (18%)
To present teachers and texts as the scientific authority	16 (27%)	1 (4%)	29 (26%)	46 (24%)
Total	59 (100%)	23 (100%)	110 (100%)	192 (100%)

To Label Objects

In each classroom, the teachers used specific words to label objects or occurrences in nature. In addition, they wanted students to be able to label specific objects in nature. Carl stated, "If I could take them outside . . . and say alright find me a tap root, find me a fibrous root, find me a woody stem, find me a flexible stem . . . I mean that vocabulary usage in context" (interview3). He wanted students to be able to recall the word and the meaning in order to apply it to the real world. During a unit on the skeletal and muscular system, Don used a word web with science vocabulary on it as a foundation of common knowledge so that the students were "all receiving some of the essential need-to-know information" (interview1) such as what the names were for different muscles and bones in the human body.

Trish emphasized scientific labels so that her students would learn to be specific in their explanations. This meant that "in science if you don't specifically say the right thing . . . [or] choose the right words and explain something on a test or on an assignment, I won't give full credit because you haven't given the correct answer" (interview3). For example, she told students that for an upcoming quiz, they needed to know the proper names of the shapes of different bacteria; she would not accept answers like "the hotdog-shaped bacteria" (observation1). She commented, "We have vocabulary, so [students] can learn to use [it]" (interview2). She expected that students learn the appropriate labels for whatever scientific concept they were learning.

To Present Fixed Definitions

The teachers presented students with specific definitions and associated factual information for labels. For example, during Don's skeletal and muscular unit, the

students searched for fixed definitions for labels related to the muscles, bones, and joints of the human body. Then, they presented them using student-created posters, presentations, essays, or labeled models.

In Carl's class, to help his students learn vocabulary words, he provided definitional information, contextual information using sentences, or both (Stahl, 1986). During one lesson, he asked the class for an explanation of the word *meadow*, and students yelled descriptions that Carl summarized by saying "a clearing, grassy field" (observation1). He seemed to rely on fixed meanings for words. During another lesson, Carl pointed to the names of organisms listed on the board and asked, "What should we call them?" He paused for a few seconds, looked around the class, and then wrote and said "producers" (observation1). He expected students to understand fixed meanings for vocabulary words with little guidance from him as to why a particular word was the correct label for something.

Trish's science classes always began with a scientific label and fixed definition that were written on the front chalkboard and that students copied into their science notebooks. Sometime during class Trish would bring up the vocabulary word that was on the board, repeating the definition and defining it in more detail. She presented definitions "in isolation even though I know [you're] not supposed to do it that way" (interview3). When asked to explain, she continued:

> Oh, they tell you that in teacher college, you're not supposed to do anything in isolation, everything has to be in context. And it ends up being in context but it's written on the board in a list and they keep it in their binder in a list. . . . If it's a word that's tricky to use, then I'll use it in a sentence for them, or if it's a word that can be confused, then I'll say it's not this, it's this. (interview3)

Trish relied on fixed, definitional information to label scientific concepts (Stahl, 1986; Sutton, 1996) and used contextual information when she felt the word was difficult to understand.

To Learn More Science

The teachers in this study understood science vocabulary as the means of learning more and excelling in science. Carl held the perspective that vocabulary was "one of the biggest pieces of science . . . [and that] science at this age is building a vocabulary base" (interview2). Due to the vocabulary that Carl felt his students needed to know for the state's 4th-grade standardized science test, he stuck to a rigid curriculum timeline throughout the school year and expected that his students learn a different list of vocabulary words by the end of each week.

According to Trish, scientists "have to be very specific in [their] word choice" (interview1), so her students needed to do the same in order to excel in science. She felt that knowing the words enabled them "to really participate in the actual learning involved in different activities" (interview3) in class. Trish believed this also prepared her students to be successful on tests and quizzes for which they would have to match definitions to science vocabulary words. Carl held a similar perspective of vocabulary in his explanation of how he challenged some of his students. He noted that "the high level group flew through cells. . . . We got to do extra stuff, in-depth stuff with like osmosis. . . . We got extra cell structures in there that they don't have to know but they enjoyed it" (interview3). He felt that he could give his higher-ability students a more in-depth science experience if he taught them more vocabulary words and definitions.

To Present Teachers and Text as the Scientific Authority

In each classroom, the teachers presented themselves or used other sources as the authority for scientific labels and definitions. They used textbooks, dictionaries, children's books, science videos, curriculum guides, and their personal knowledge of science to create definitions for their students. Carl valued the knowledge in textbooks and used them to "take important vocabulary out" (interview2). He also chose words based on what his students were expected to know for the state's 4th-grade standardized science test, and he stated, "Most of the lessons, most of the discussions, are based on those vocabulary words and the concepts that are involved with those vocabulary words" (interview2). Sometimes Don had his students find their own definitions for words, yet even in this situation, an outside source, not the students, was the authority for the definition. Trish chose the vocabulary words for her lessons based on their frequency during a unit, their importance for students' success on the unit test, or what was in the textbook. She tried to present an assortment of words for the variety of learners in her class such as "easy" words that students had learned before or that pertained to concrete concepts and "hard" words that students had never learned before or that pertained to abstract concepts. Yet, Trish was the authority, not the students, when deciding which words were most difficult for them.

Teachers' Uses of Language as an Interpretive System

Sutton (1996) reported that teachers who use a variety of words for describing scientific information are helping students understand language as an interpretive system. There is an assumption among these teachers that meanings can vary "from person to person as well as from context to context" (p. 14); meanings of words are debatable. These teachers encourage their students to choose words that will help others see their point of view and model the same practice. The teachers in this study used this form of language to a much lesser extent than language as a labeling system. Table 2 shows how often features of language as an interpretive system were documented in observations, interviews, and artifacts during this study. The percentages in each column, provided to assist the reader with comparisons among teachers, show the distribution of usage for each teacher and for each category of language as an interpretive system. It is important to note that although we discuss the characteristics separately, they are interrelated. For example, Don geared some of his lessons toward helping students understand scientific processes and skills rather than specific words and so relied on language as an interpretive system to help his students learn what it meant to do science. Below, we present specific examples for the characteristics of language as an interpretive system using codes that we placed on the data. These codes, while grounded in Sutton's framework, emerged from the analysis of all three teachers.

Table 2. Occurrences of Language as an Interpretive System

Type of Occurrence	Carl	Don	Trish	Total
To explain science in alternate ways	2 (25%)	0 (0%)	4 (80%)	6 (30%)
To create personal definitions and share authority	4 (50%)	3 (43%)	0 (0%)	7 (35%)
To use available language and share authority	0 (0%)	1 (14%)	1 (20%)	2 (10%)
Total	6 (100%)	4 (100%)	5 (100%)	15 (100%)

To Explain Science in Alternate Ways

The teachers occasionally used analogies and nontechnical language to explain science concepts. This use of language was evident in some of Carl and Trish's lessons and interviews. During one of Carl's lessons, he gave the following explanation:

> Stagnant is like when it rains, if there is something that's catching the rain, like a bucket, and then you leave the water in the bucket for a few days and afterward, when you look at it again, it's dirty and has things in it. (observation2)

He used an analogy of rain water in a bucket to explain the scientific word *stagnant*. Trish occasionally presented definitions using contexts that students might understand. During one observation, she explained the vocabulary word *aerobic* by referring to how people often take an aerobics class. She asked, "How do we get more oxygen, like when we're exercising?" Some students responded by taking a deep breath in, and Trish mentioned that "we breathe heavier in order to get enough oxygen when we're exercising" (observation1). She made an analogy to other natural phenomena to help her students understand the scientific term.

To Create Personal Definitions and Share Authority

Occasionally the teachers allowed students to create their own definitions or explanations of scientific phenomena based on their prior knowledge and new ideas. Carl referred to this as "build[ing] a definition" (interview2) of each word. For example, one week the word *community* was part of Carl's science vocabulary list. To help them build a definition, Carl began by

> having them explain what they know about a community and . . . they will talk about their family and friends and neighbors. Then I will ask them how the bear in the story is part of a community, and they will refine the definition and base it in the science of the week. (interview2)

Carl recognized that students understood scientific words based on contexts that were not scientific, and he accepted this to help them interpret science vocabulary. In this situation, Carl shared authority with the students regarding the definitions for scientific terms because they created a definition together, using what the students already knew about the word.

To Use Available Language and Share Authority

Teachers in this study sometimes encouraged students to use whatever words they had available to them at the time to explain scientific phenomena. In many of these situations, the teachers shared authority with the students regarding technical terms and definitions by first allowing the students to use their own way of describing natural phenomena. To begin a unit on variables, Don presented a discrepant event where he threw a paper airplane and wanted the students "to start thinking about what they saw happen, what I did, what their observations were, . . . and then [make] suggestions for how I could straighten the plane out" (interview1). He used the students' suggestions for changes to help them understand the scientific term *variable*. Although he eventually attached a label to what the students were doing to help him, this came after the students and he used their own language in the context of a particular classroom event.

Trish recognized that her students would interpret scientific phenomena using terms they were familiar with, even if those terms were not technical science words. She noted how "They tend not to sit there and say, 'Oh the light is diverging.' They'll go, 'Look! It's going off that way!'" (interview3). She explained that she uses the correct science words when she teaches, but she knew that "some of [the students] don't use the words because they haven't internalized them yet" (interview3), and that was acceptable for a short time.

Discussion

Carl, Don, and Trish used both language as a labeling system and language as an interpretive system to increase their students' knowledge of scientific words and science as a discipline. Tables 1 and 2 show how extensively language as a labeling system was used in these classrooms compared to language as an interpretive system. The tables also show an uneven distribution across teachers and across features of the two types of language. Given that the number of observations, interviews, and artifacts collected for each participant varied, comparisons among the teachers must be made cautiously. Differences among the teachers' usage of vocabulary may be related to the researchers' methodological decisions rather than classroom and teacher contexts. Contrarily, Trish was the only teacher in the study to use a textbook to aid instruction, and Carl was the only teacher to use a state-mandated standardized test to aid instruction. Textbooks and standardized tests contain much science vocabulary. Future research should look more closely at how these pedagogical tools drive the scientific language use of teachers.

Carl, Don, and Trish's uses of the two conceptions of language were evident through the particular practices shown in Table 3. These practices support Sutton's (1996), Norris and Philips' (2003), and Gee's (2004) descriptions of how language is used in science. In addition, this study provides a concrete and classificatory way to view teachers' understanding and uses of scientific language, particularly as it relates to teaching science vocabulary to elementary students. As indicated in Table 3, when the teachers in this study used language as a labeling system, they did not discuss with their students or the researchers how an object first received its label and definition. They presented vocabulary and definitions as universal and definitive constructs. This may have been why none of the teachers attended to how scientists used what came before them to form new ideas and explanations about nature, an important feature of language as an interpretive system. Perhaps this feature of scientific language is not compatible with a teacher's lack of explanation

for how objects received their labels and definitions. It may be that if teachers understand scientific language as one where definitions are placed onto labels for objects, then they do not attend to how scientists use what came before them to present claims about science. This should be addressed in future research.

Table 3. Characteristics of Scientific Language in the Teachers' Science Lessons

Language as a Labeling System	Language as an Interpretive System
• Using specific words to label objects in the natural world	• Using analogies to explain scientific words
• Presenting fixed, specific definitions and factual information for science vocabulary	• Constructing personal definitions for scientific words based on prior knowledge and new observations
• Learning more about science means learning more scientific words and definitions	• Using language available at the time to explain what is observed in the natural world or classroom laboratories
• Teacher or science texts are the authority for scientific labels and definitions	• Teachers and students share responsibility for explaining their understanding of scientific words and meanings
• No explanation of how an object received its label and definition[a]	• Learning science means learning how scientists used what came before them to make claims about nature[b]

[a] This characteristic was implicit in how teachers talked about, taught, and used science vocabulary in their lessons.

[b] This characteristic was not evident in any of the three teachers' science lessons or in how they talked about science vocabulary.

Carl, Don, and Trish mentioned other uses of vocabulary in their science lessons. They recognized the importance of knowing what scientific words mean in order to read and comprehend the books and tests that were a part of their curriculum. This is typical of why most teachers focus on vocabulary (Nagy & Herman, 1987). For Carl, whose 4th graders must take a state-mandated standardized science test, it was necessary to "try to get as many of those vocabulary words in there so that the kids can at least recognize . . . key words and say 'alright, okay I know this word'" (interview3) and therefore do well on the test. Don felt his students needed a common core of vocabulary knowledge in order to successfully look up skeletal and muscular information in science trade books, online, and in textbooks. Trish explained that she had students copy the vocabulary word and definition at the beginning of class so that "if we are reading, we don't have to stop, open our binders, copy the word down, and lose the momentum of reading through the text" (interview2). This way the students knew the vocabulary before encountering it in their reading.

Yet, when language as a labeling system is used to improve science reading comprehension, vocabulary learning cannot be simply memorizing definitions: "words must be treated as labels for concepts that are embedded in larger schemata" (Nagy & Herman, 1987, p. 30). Students must be provided with multiple exposures to both definitional and contextual information about vocabulary in order to truly learn it and use it in their reading, writing, and speaking (Blachowicz, Fisher, Ogle, & Watts-Taffe, 2006; Greenwood, 2002; Stahl, 1986; Stahl & Fairbanks, 1986). For example, Trish described how she used lab activities to help her students understand the "high level vocabulary" (interview1) in the textbook. She had her students "read [the textbook],

do an activity with it, [if] they're a little shaky on it, do something else with it, . . . [and] reread it again" (interview1) so that they could understand the science vocabulary. Trish used lab activities to confirm the science concepts presented in the textbook.

This study only begins to examine how teachers use vocabulary in science, but it has important implications for teacher education. Although reading a science text encompasses a large part of doing science in school, "it is not all of science" (Norris & Phillips, 2003, p. 230). Sutton (1996) argued that students should become familiar with both types of language to best understand science. Language as a labeling system is needed in science classes to allow students to further understand concepts, but in the classrooms in this study it was overused. Little attention was paid to language as an interpretive system, particularly the transition from interpretive language to the technical terms of science. Missing from the lessons in this study was the role that interpretive language plays in the debates and controversy surrounding many scientists' claims before they become the accepted facts presented in science texts. By not using language as an interpretive system, teachers may sustain "the picture of easy fact-finding as the basis of science" (p. 6) because students misunderstand how scientists got to the point of being able to passively transmit facts to them.

Teacher educators must help teachers decide when and how to use both conceptions of language in their classrooms. This can be aided through discussions about and experiences with scientific inquiry for teachers, providing a foundation for understanding when each type of language could occur in science lessons. Inquiry experiences allow students to develop their own explanations and descriptions of scientific phenomena (NRC, 2000). This can support vocabulary learning by establishing ties between new words and prior knowledge and by presenting "new words and concepts in the context of larger domains of knowledge" (Nagy & Herman, 1987, p. 30). Teachers can accomplish this through science instruction that shows students how scientists used what came before them to create additional knowledge in science. This is language as an interpretive system, supported through inquiry science and thereby allowing students to understand language as a labeling system as well.

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Correspondence regarding this article should be directed to

Nicole J. Glen
Bridgewater State College
Elementary & Early Childhood Education
Hart Hall, Room 130
Bridgewater, MA 02325
(508) 531-2483
Fax: (508) 531-4483
nglen@bridgew.edu

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