Toward Integration: An Instructional Model of Science and Academic Language

Cecilia Silva, Molly Weinburgh, Robert Malloy, Kathy Horak Smith & Jenesta Nettles Marshall

College of Education, Texas Christian University, Fort Worth
Ilima Intermediate School, Ewa Beach, Hawaii
Mathematics Department, Tarleton State University, Stephenville, Texas

Published online: 01 Mar 2012.

To cite this article: Cecilia Silva, Molly Weinburgh, Robert Malloy, Kathy Horak Smith & Jenesta Nettles Marshall (2012) Toward Integration: An Instructional Model of Science and Academic Language, Childhood Education, 88:2, 91-95, DOI: 10.1080/00094056.2012.662119

To link to this article: http://dx.doi.org/10.1080/00094056.2012.662119
School success in the United States is grounded in English-based academic literacy. As the number of English language learners (ELLs) entering schools continues to increase, more elementary classroom teachers are faced with the challenge of providing opportunities for students to acquire a new language in conjunction with the acquisition of content knowledge.

Most elementary teachers are comfortable with teaching the language skills of reading, writing, listening, and speaking; thus, they approach most lessons "with an emphasis on language and texts" (Lemke, 2004, p. 33). As generalists, though, elementary teachers are less likely to have had opportunities to develop the skills, knowledge, and dispositions necessary to cultivate learning through inquiry-based lessons. In contrast, teachers with strong science education backgrounds are more likely to use inquiry and approach a lesson "with questions about how things happen in the world" (Lemke, 2004, p. 33). They begin a lesson with the experience, positing that exploration before explanation can enhance science concepts learning (Bybee et al., 2006; Lawson, Abraham, & Renner, 1989; Schwab, 1966). Science teachers generally are not as familiar using strategies to enhance emerging language skills; thus, they may not recognize opportunities to make language explicit to the learners.

However, both generalists and science teachers must realize the value of language in context and the importance of situated meaning, whereby word meaning changes with context. Gee (2004) further explains that situated meaning is "rooted in embodied experience" (p. 19), not merely in
An inquiry-based science lesson engages students mentally and emotionally with ideas (posing a question, developing a plan, making evidence-based arguments, revising and clarifying their ideas) as well as physically with materials (making models and manipulating variables). The shared, hands-on experience provides the children with an anchor or context that gives relevance to the new language needed to communicate about the experience. Children are “more likely to learn words that they have heard in meaning-rich contexts—contexts in which there were demonstrations of the word’s meaning, or connections drawn between the unknown word and other known related words” (Snow, 2008, p. 78). Scaffolded science inquiry can provide a context for language development.

Here, we outline an instructional model that can be used to optimize science and language learning in the classroom. The authors have developed the 5R instructional model (Weinburgh & Silva, 2010) to support teachers as they integrate academic language into content instruction. The model combines five strategies already familiar to teachers helping ELLs understand and begin to use academic language. With thoughtful planning, four of the strategies—replace, reveal, repeat, and reposi-tion—are utilized by the teacher as opportunities emerge within the lesson, and are context-anchored. The fifth strategy—reload—can be used by teachers to reinforce language introduced in previous lessons, and is context reflective. (See Figure 1.)

**Setting the Science Context**

The model we propose emerged from three years of teaching summer school to recently immigrated elementary students in a large urban district. While the content selected was science, we emphasized acquisition of academic language. The goal for the summer program was to address the National Research Council (1996) standard stating that 4th-grade students should have an understanding of how the earth changes, and so we chose an erosion unit using the inquiry approach.

We began by eliciting prior knowledge about erosion, asking the students to fill out the K and W portions of a KWL chart. Next, we took the students on a field trip around the campus to see if they could identify places where erosion had occurred. During the 15-day unit, the students used stream tables to model the erosion process and indentify evidence of erosion. They changed variables to answer the teacher-initiated question, “What will happen to my sandy field if we have a gentle rain on dry ground?” Students then moved through a progression of questions: “What will happen with a gentle rain on wet ground?”; “What will happen with a hard rain on dry ground?”; “What will happen with a hard rain on wet ground?” Each day, the students worked with their stream table models as they discussed, journaled, and read about erosion. Throughout the inquiry, the students built conceptual understandings of erosion, improved their science process skills, and developed literacy skills. (See Figure 2.)

**Supporting Academic Language Acquisition in a Science Lesson**

For success in science, all students are expected to advance in academic language. Students must be able to use oral and printed language that represents the practices of the scientific community. ELLs usually develop conversational fluency within two years of exposure to English. The academic language proficiency required in school, however, may take five to seven years to develop and is cognitively more demanding (Cummins, 2000; Hakuta, Butler, & Witt, 2000). Unfortunately, the development of academic English is frequently ignored (Scarcella, 2002, 2003).

One feature of academic language that often challenges ELLs is the lexical component or academic vocabulary related to science. In addressing the relation between knowledge of scientific words and scientific knowledge, Snow (2008) discusses the emphasis that is placed on the development of scientific vocabulary within science textbooks—particularly in biology instruction.
Snow argues that students must develop an understanding of the knowledge and perspective that reflects the scientific discourse critical to learning how to think like a scientist: “Without this kind of knowledge (which researchers refer to as ‘theory of mind’), understanding terms like claim, deny, disprove, and provide evidence for, which are central to scientific discourse, is impossible” (p. 81). Knowledge of appropriate vocabulary allows scientists to efficiently communicate the details that describe a phenomenon they are investigating—evidence, materials, and conclusion—so that others can understand and replicate them.

While researchers do not call for the explicit teaching of the various linguistic components of academic English, they do emphasize the role of the teacher in scaffolding features of academic language within science instruction (Gee, 2008). Furthermore, researchers propose that vocabulary development should be context-based (Cummins, 1996; Gibbons, 2009) and should emerge from the science activity.

The 5R Model—replace, reveal, reposition, repeat, and reload—can be used to scaffold specialized science language within the context of science lessons. The 5Rs naturally emerge when teachers are aware of the content as well as the language that ELLs will need to comprehend and express meanings within the science lesson. As more classroom teachers working with ELLs engage in backward design curriculum planning models (Wiggins & McTighe, 2005), they not only identify content learning outcomes, but also anticipate the academic language that students must develop in order to fully participate in the curriculum (Colombo & Furbush, 2009; Echevarria, Vogt, & Short, 2010; Freeman & Freeman, 2009). In these classrooms, teachers understand that for ELLs to succeed, they must acquire the academic vocabulary as well as the writing styles of each discipline.

Replace
Students begin talking about their science experience by using language that is familiar. Encouraging the use of everyday language is a superb way to introduce students to the inquiry process and engage them with the phenomenon being studied. As the students discuss the science, the teacher uses every chance to help them change or replace the everyday language with scientific language. A replacement is a one-to-one correspondence in which one or two words used in everyday language are substituted with more appropriate academic language to represent concepts used in the science classroom. In the following example, the teacher is using a stream table to point out evidence of erosion:

T: Let’s look at this student’s stream table [the stream table was placed on a document camera so that all the students could see it; the teacher points to a formation]. What is this?
S: A line.
S: A canyon.
T: It does make a line in the sand. We could use the word canyon, but there is another term we can use. Because it is small, we call it a gully.

The following interaction provides another example:

S: Can I draw a picture of what I saw?
T: Yes, that is a good idea.
S: I looked for things that showed that erosion happened.
T: We could say that you are looking for evidence of erosion.
S: Evidence?
T: Yes, when we have things that show us that something happened, we can say we have evidence.

Students are given academic words to replace the more common words or phrase. The everyday language remains a part of their total vocabulary, even as they are learning to use the academic words when talking about the science concepts.

Reveal
Some academic words do not have a corresponding word in everyday language. In planning a lesson, the teacher looks ahead to the language that a child needs to acquire to be proficient in the subject and is prepared to reveal the new, distinctive vocabulary. This backward planning allows the teacher to identify the concepts that need to be studied in preparation for creating opportunities that will reveal new terms. In the following example, the students were introduced to the proper name for the equipment they would be using to conduct their experiments:

March/April 2012 / 93
T: This is called a stream table. S-T-R-E-A-M table.
Give me another word for stream.
S: A river.
S: A creek.
T: This is called a stream table because we are going to use water like you find in stream. We could call it a creek table or river table, but someone before us decided to call it a stream table. We use a standard language so we all know what we are talking about.

The following conversation occurred as the students were considering what factors could cause erosion:

T: We were looking for agents of erosion. What is an agent?
S: Secret agent?
T: That is a way we often use the word agent. Let’s think more about what I would mean by an agent of erosion. We could say that we are looking for something that makes erosion happen.
S: Something that makes it happen?
T: Yes, an agent of erosion is the thing that makes erosion happen.

The teacher uses the strategy of revealing to be sure that vocabulary is introduced into the lesson as it is needed to help enhance learning.

Reposition
Certain ways of speaking and writing are more common in science. A task for teachers is to model the use of scientists’ language and encourage the students to shift from everyday discourse toward the academic shared discourses of specific disciplines. Repositioning is a way for the teacher to mentor the students in the intricacies of the language: “The development of literacy within any subject in the school curriculum involves learning the technical language, grammatical patterns, and generic structures particular to the subject” (Gibbons, 2003, p. 252). Gibbons further emphasizes the critical role of the teacher in co-constructing meaning by building the linguistic bridges that move ELLs from unfamiliar ways of using the language to those that more closely reflect the linguistic register of the content area. In our model, repositioning refers to the teacher’s conscious role in co-constructing these new ways of using academic language. An example of repositioning follows:

T: What did you see happening in the stream table?
S: When the sand moved.

S: The hole.
S: A ditch, we saw a ditch.
S: The pile of sand.
T: What do we call the pile of sand?
S: Alluvial fan.
T: And the ditch?
S: A gully.
T: All of these are true, even if we did not see the sand move, see where it was, and see where it piles up. So I could say, “I see that the process of moving earth materials—sand—by a natural force—water—has happened.” Do you agree?
S: Yes.
T: We do not have to say the long sentence “moving earth materials by a natural force,” but can just say “erosion.” A scientist would say, “I see evidence of erosion.”

By moving from the more common way of expressing an idea to the more concise and conceptually dense language generally found in textbooks, the teacher can help the students begin to have an understanding of the grammatical patterns that are used in academic science language.

Repeat
Hearing and saying a new word many times is beneficial for acquiring academic vocabulary. The teacher can help the students develop ownership of an academic word or sentence structure by using the label or grammatical form as often as possible. In the following example, the teacher models the word in multiple sentence structures to familiarize students with pronunciation and various usages of the word.

T: I want us to think about what we know about models. Earlier, we were talking about the 3-D models you made with clay. Let’s look at the model that one group made. I can tell where you were on the campus from looking at the model. What is this a model of?
S: The creek.
T: Yes it is. Scientists also make another kind of model. They make a model to see if they can answer their question. We will make a model to help answer our question about the effect of rain on my yard.

Reload
Replacing, repeating, revealing, and repositioning naturally emerge as the teacher seeks opportunities to use key academic vocabulary and grammatical forms within the lesson. In contrast, reloading occurs after the target language has emerged
within the lesson, and it provides students with the opportunity to develop metalinguistic awareness or word consciousness (Anderson & Nagy, 1992). Reloading is different than strategies often advocated for use in ELL settings in which vocabulary instruction often precedes the lesson (Echevarria et al., 2010). Through reloading, students discuss words that had been previously introduced within the context of the science lesson. During this phase of the 5Rs model, previously introduced vocabulary words are formally defined while students engage in discussions that highlight various features of the word. For example, students might compare everyday words with academic words (e.g., guess/hypothesize) or consider whether the words reloaded reflect science content or processes (e.g., alluvial fan/hypothesize). When appropriate, ELLs also identify cognates—words that have the same linguistic root and are similar in spelling and meaning (e.g., Spanish hipótesis and English hypothesis). Reloaded words are then placed in the word wall for future reference and further revising activities. Reloading is a purposeful action that engages students in reading, writing, speaking, and listening.

CONCLUDING THOUGHTS

Having used the 5R Instructional Model with ELL students, we believe that it is a powerful teaching tool that can benefit not only ELLs but all students. We believe using this model helps students develop the academic and transitional language necessary to engage in the specialist discourse of the sciences.

References


Author Note

This article forms part of a larger study on acquisition of language and content knowledge for English language learners partially funded by the JPMorgan Chase Foundation, and by the Andrews Institute and Center for Urban Education in the Texas Christian University’s College of Education.