Promising Instructional Strategies for English Learners in the Science Classroom

Sarah Tahtinen-Pacheco and Jessica Merchant

For English learners to thrive in the science classroom, teachers should build on a foundation of effective instruction and then explore what a partnership between content and language teachers can offer.

Partnering to support academic achievement: The TESL professor and the science teacher

Academic language development for English learners (ELs) has become the new focus in many K-12 content-area classrooms. While many teachers have been exposed to current ideas in academic language development and want to include it in their classroom teaching, they are often not sure how to begin. This can be stressful for content teachers who have not been formally trained in teaching English as a second language, and challenging for ESL teachers put in the position of teaching content outside the realm of teaching language.

Effective instruction to promote academic achievement for ELs requires integration of content and language (Lee & Buxton, 2013). Due to the steady growth of ELs in U.S. schools, there is a continued need for language and content teachers to collaborate and support academic language development in content-area classrooms. In this article, we will share what we learned when a TESL professor (Sarah) and an in-service science teacher (Jessica), collaborated to find practical ideas to teach academic language in the science classroom.

It's more than vocabulary

The academic language skills required for students to be successful in science are challenging for all students. Science is often taught—or perceived by students to be taught—as discreet chunks of decontextualized information to be memorized. Students are therefore able to recite isolated "chunks" of science content, but lack the academic language skills necessary to communicate deeper content understanding by applying learning to new situations, or providing strong evidence to support a claim. ELs, then, have the added challenge of developing these important skills while becoming proficient in a new language.

Science teachers often want to stress vocabulary more than any other language skill, because science vocabulary is difficult. This is a legitimate point, and emphasis on building vocabulary with ELs is critical. However, if students cannot *use* their acquired vocabulary, they will always struggle with the higher order thinking skills associated with scientific academic language (Nutta, Bautista, & Butler, 2011). We must help students move beyond an understanding of science as rote memorization of challenging words. If a student has to read, write, speak, listen, or think about something in science, then it involves academic language skills. For example, when students graph the results of an experiment, they are developing graphing skills *and* the important academic language skills of analysis and inference.

In the urban high school where Jessica teaches, there is a high percentage of ELs from East African countries, primarily Somalia and Ethiopia. The academic language needs in this classroom are likely no different from those found in other science classrooms with many ELs and include:

- Using scientific language in writing and speaking
- Utilizing higher order thinking skills to attain deeper content understanding
- Providing evidence to support claims in thinking, writing, and speaking

Science and ESL teachers, wanting to improve the achievement outcomes of their EL students, can utilize language activities and strategies to promote these skills and practices in the meaningful context of science. The foundation of working together begins with finding common ground and focusing on the strengths of collaboration rather than feeling overwhelmed by lack of experience individually.

Foundations we share, or best practices in any teaching

Best practices in content-area classrooms can become essential practices when working with ELs. They provide a foundation of support for acquiring language. Many instructional strategies will support academic language development in both ESL and content classrooms:

1. *Build relationships with students*. What prior experiences do they bring? How can you use this information to connect them to new concepts and vocabulary? What cultural values and ideas related to science are important to know? The more you know about each student, the better prepared you are to support their learning. It is essential to know where students are in their understanding of concepts in order best support linguistic and conceptual development.
2. *Review textbooks and materials* to identify essential concepts, language patterns, and vocabulary necessary to access the content. Determine which of the concepts, language patterns, and vocabulary are required repeatedly in the content.
3. *Teach identified academic vocabulary through direct instruction*, and meaningful visual and oral repetition. When choosing which academic language to develop, teachers can ask the following questions:
    - Is the word used repeatedly and is it essential in understanding the science content?
    - Will the word be used in other science units or classes?
    - Is the word used in other contexts and academic content-areas, such as functional words? Are the meanings similar or different?
4. *Begin lessons by activating prior knowledge* through purposeful questions or scenarios.
5. *Model academic vocabulary and language functions* through explicit teaching and use of content-area register.

6. *Engage students through the use of hands-on inquiry-based activities*. During the inquiry process, provide students with significant language practice before, during and after inquiry through speaking, listening, writing, and reading.

A model for inquiry*: E*ngage, *E*xplore, *E*xplain, *E*laborate, and *E*valuate

Science becomes more accessible to ELs when they can explore and discover patterns, characteristics, and rules during hands on experiences (Nutta, Bautista, & Butler, 2013). One of the most popular methods for teaching guided inquiry is the 5E's, which stands for *E*ngage, *E*xplore, *E*xplain, *E*laborate, and *E*valuate (Bybee, 1997). During the *engagement* state, teachers will assess what students already know about a topic. In the *exploration* stage, students perform investigations related to the scientific phenomenon. At this point, it is helpful for teachers to provide guided questions to help ELs document their learning. For example, an exploration related to density might include the following guiding questions and sentence frames:

Challenge: Discover how weight and bottom area determine how high or low the vials float.

Guiding Questions:

i. What did you find out?
I found out that _____ *sinks low when* _____
I found out that _____ *floats higher/lower than* _____

ii. How is bottom area related to how high or low an object sinks?
If the bottom area is _____ *, then it will float / sink*

iii. How is weight related to how high or low an object sinks?
If the weight is _____ *, then it will float / sink*

Guiding questions and sentence frames often include "tier two" vocabulary words that often occur across content areas, and sometimes have multiple meanings (Beck, McKeown, & Kucan, 2002). Tier two words from the above example include "related" and "determine." Other commonly used tier two words include: characteristic, describe, coincidence, and fortunate. Explicitly teaching ELs these words will help them succeed in science, as well as other content area classes.

During the *explanation* stage, students share their results and the teacher uses the students' experiences to explain the new concept. During this phase, ELs need to practice producing the language from the guiding questions with each other and in writing. Practicing with sentence frames and with their peers will help prepare them to write a short explanatory paragraph or notes on their own. This should not be used as evaluation, but as an ongoing part of the inquiry and language development process. In the *elaboration* phase, students apply the new knowledge to a new situation. The final *evaluation* stage involves assessment of the student's progress and reflection on what they have learned.

Scaffolding during inquiry with the Science Writing Heuristic

Students can document their learning in the e*xplanation, elaboration, and evaluation* phases using the Science Writing Heuristic (SWH) (Keys, Hand, Prain, & Collins, 1999), which is an effective method that scaffolds student learning during an inquiry investigation. SWH is a set of seven guiding questions that serves as an outline which replaces the standard lab report, and can be modified to suit the learner's proficiency level:

(1) What are my questions?
(2) What do I do?
(3) What can I see?
(4) What can I claim?
(5) How do I know? Why am I making these claims? (This is considered evidence.)
(6) How do my ideas compare with other ideas?
(7) How have my ideas changed?
(Burke, Hand, Poock, & Greenbowe, 2005. Cited in Nutta, J.W., Bautista, N.U., & Butler, M.B., 2011.)

Modifications of these questions could include adding pictures or diagrams, sentence frames, or a word bank to further support language development. Effective science teachers model and support of a variety of academic language functions in the context of science inquiry as students generate questions, formulate hypotheses, design investigations, collect and interpret data, draw conclusions, and communicate results (Lee & Buxton, p.38). These provide important content experiences for students while learning the language.

Activities to promote and support the development of academic language in the science classroom

Pre-writing and thinking activities

Quick Writes and Think-Pair-Shares are effective Sheltered Instruction Observation Protocol (SIOP) activities that help students activate prior knowledge and think about what they already know (Short, Vogt, & Echevarria, 2011). Quick Writes are 2-5 minute writing exercises in which students write everything they know about a topic. Teachers can modify this activity to have students write about previous lessons, or write about questions they have related to a particular topic. Think-Pair-Shares is an effective means for students to practice speaking either before or after classroom discussions or writing prompts. Students first *think* quietly about the question or problem posed by the teacher, then they *pair* up with another student, and *share* their ideas prior to sharing out in a large group. This can be especially helpful for ELs in science, because students are often too intimidated by the material to volunteer an answer without confirming it with another student first.

Working with partners or small groups can help promote academic language use when students are given specific frameworks for developing those skills. For example, to develop the skills of paraphrasing and summarizing, students might take turns reading descriptive paragraphs from

a text and verbally summarizing to a partner before collaboratively completing a graphic organizer such as a T-Chart or Venn Diagram. Teachers can provide posters for "Signal Words" (Short, Vogt, & Echevarria, 2011) that students should use when they are asked to compare/contrast, write a description, write a procedure, etc.

Writing and speaking activities

The following activities focus specifically on writing and speaking practice, and are particularly suited to science content. "Milling to Music" is a partner-based discussion activity. With music playing, students walk around the room; once the music is stopped, students pair up, and the teacher provides an open-ended prompt. Prompts should be open-ended and allow for discussion between students on a particular topic. After the allotted time, the music starts again, and the process is repeated for 5-15 minutes, depending on type and amount of questions. The activity can be modified to include sentence frames or signal words posted on the board. Milling to Music promotes academic language use through open-ended discussion with peers, assuming students have had previous exposure to the content. After the activity, students might respond to a writing prompt, or group reflection.

Another activity that is conducive to reviewing material while using academic language in writing is a "simultaneous round table." In this SIOP activity students respond to an open-ended prompt on a piece of paper. Working in groups of 3-5, students then pass their papers to the next person in the circle. Students read what was written by their peers, and then either build on what was previously written, or add a new idea. This gives students the opportunity to see the thought process of other students, as well as focus on developing ideas in a group. At the end, students have lots of starters for a group or classroom discussion.

Helping students write scientific explanations with CER

Claim Evidence Reasoning (CER) is a framework designed to help students write scientific explanations that are supported with evidence and logically reasoned (McNeil, K. 2011). A scientific explanation is composed of three parts: a *claim* that answers the question, *evidence* from data (at least three pieces), and *reasoning* that links the evidence with the claim, often using a scientific principle, and provides a justification for why the data counts as evidence. The format is simple and can be used two powerful ways:

(1) Once students are comfortable with CER, have them use it to evaluate arguments (Think: Internet searches!)
(2) Provide students with a data set (or have them collect their own), have them graph it, and then complete a CER to practice evaluating data and create strong written arguments.

CER is easily adapted for ELs. Most importantly, teach the framework carefully before expecting them to do it independently. Allow them extensive time to practice using videos (commercials work well), simple data sets that they are already comfortable with (e.g. correlation between

height and gender), and/or other non-science material. Provide sentence frames for each part of the framework that are specific to the question, for example:

Evaluating a data set relating gender and height

Claim: Girls tend to be _____ than boys.
Evidence: The graph shows that _____.
Evidence: On average, girls are _____ inches _____ than boys.
Evidence: The tallest girl is _____, and the tallest boy is _____.
Reasoning: Because the graph shows that _____, I can be confident that _____ tend be to _____ than boys.

When students become comfortable with CER, it can be a powerful tool for developing their academic language skills not only in science, but also in other content areas. It supports critical thinking by giving students an authentic opportunity to practice using academic language.

In order to be successful in school, students need to be proficient in academic literacy (Nutta, Bautista, & Butler, 2011). With the increase in linguistic diversity throughout K-12 school classrooms, it is ever more important for language and science teachers to collaborate to best support our students.

References

Beck, I. L., McKeown, M.G., & Kucan, L. (2002). Bringing words to life: Robust vocabulary instruction. New York: Guilford.

Burke, K. A., Hand, B. M., Poock, J. R., & Greenbowe, T. J. (2005). Using the science writing heuristic: Training chemistry teaching assistants. *Journal of College Science Teaching, 35*, 36-41.

Bybee, R. (1997). Achieving scientific literacy: From purposes to practices. Portsmouth, NH: Heinemann Educational Books.

Keys, C., Hand, B., Prain, V., & Collins, S. (1999). Using the Science Writing Heuristic as a tool for learning from laboratory investigations in secondary science. *Journal of Research in Science Teaching, 36*(10), 1065-1084.

Lee, O. & Buxton, C.A. (2013). Integrating science and English proficiency for English language learners. *Theory Into Practice*, 52, 36-42.

McNeil, K. (2011). *Supporting Grade 5-8 Students in Constructing Explanations in Science: The Claim, Evidence, and Reasoning Framework for Talk and Writing.* Pearson.

Nutta, J W., Bautista, N.U., & Butler, M.B., (2011). *Teaching science to English language learners.* Routledge, New York, NY.

Short, D. J., Vogt, M., Echevarria, J. (2011). *The SIOP model for teaching science to English learners.* Pearson.