MAKING THE CON

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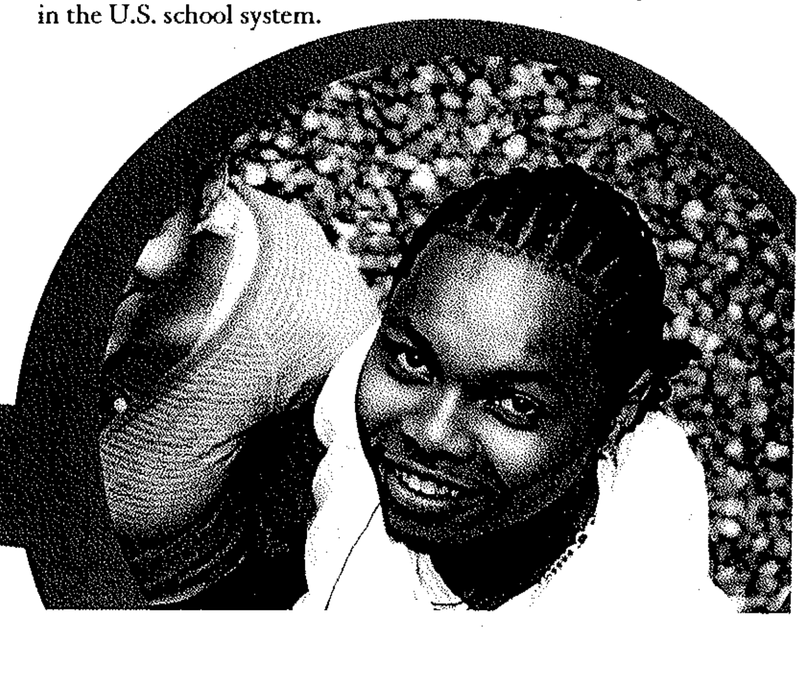
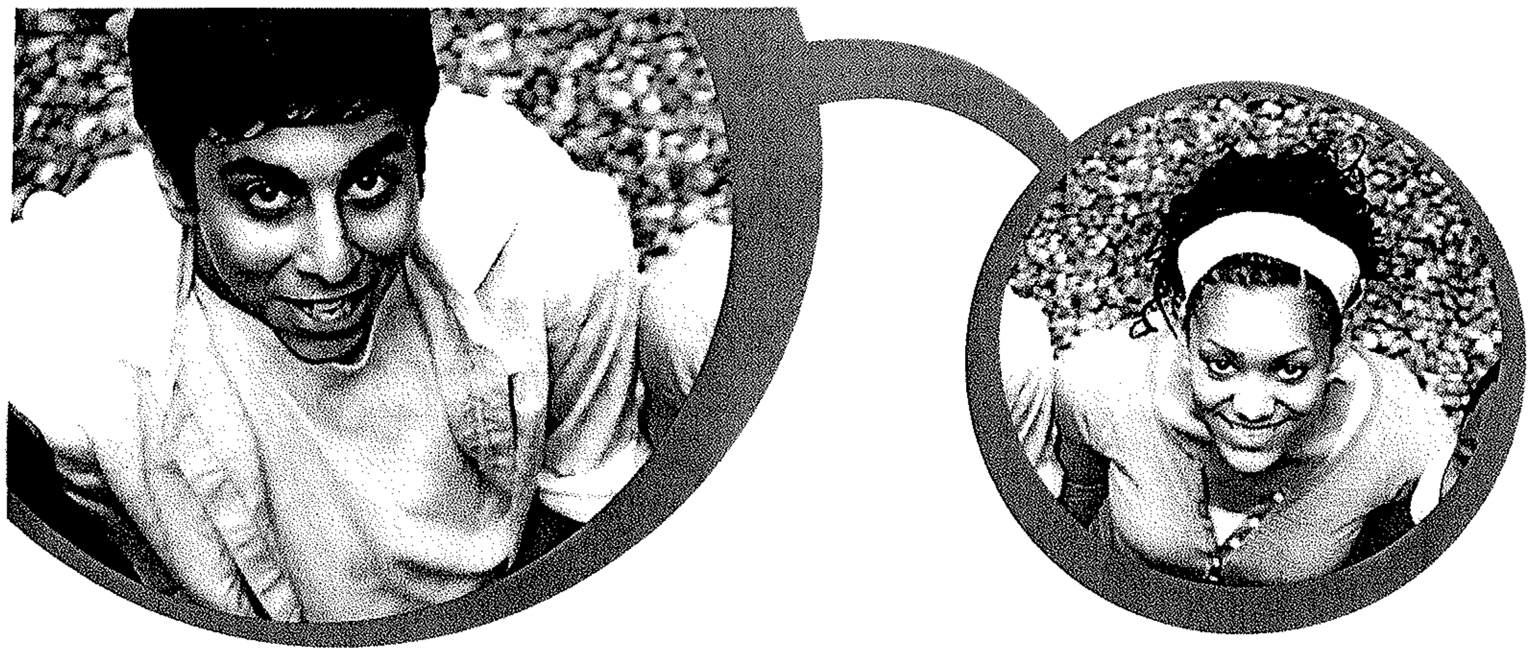
Practical techniques for accommodating English Language Learners in the science classroom

Secondary science teachers are faced with an increasing number of students whose first language is not English and charged with preparing them for federal- and state-mandated end-of-course exams. In many states, these high-stakes tests play a crucial role in making decisions about promotion, graduation, and placement. Current policies generally dictate that English Language Learners (ELLs) demonstrate language and academic proficiency in content areas such as math, science, social studies, and English after one year in the U.S. school system.





NECTION

Second language acquisition research, however, strongly suggests that it takes five to seven years—or even longer—for average ability ELLs to achieve grade-level performance (Collier 1987, 1989; Cummins 1981, 1996). High school ELLs are a particularly vulnerable population because new language acquisition becomes more difficult as students get older (Lenneberg 1967, Scovel 1988). In addition, the science curriculum includes a large amount of content-specific vocabulary, assumes extensive background knowledge, and requires sophisticated reading and writing skills (Echevarria, Vogt, and Short 2004). Given these findings, high school ELLs and their science teachers need specialized support specific to each content area while ELLs are learning English.

Science for all

The "science for all" principle guiding science education (NSF 1998, NSTA 2000) supports engaging all students—regardless of differences such as gender, backgrounds, or culture—in scientific inquiry. It is known that inquiry-based instruction can facilitate students' language learning as well as critical-thinking skills (Lee 2005). On the other hand, students with different cultural and linguistic backgrounds may be frustrated with the inquiry process itself—asking questions, investigating, finding answers on their own, and reporting results using science language (Fradd et al. 2001, Lee 2005). A logical approach to this challenge is to integrate science with literacy instruction by carefully designing instruction with attention to ELLs' linguistic and cultural backgrounds.

To ensure academic success, ELLs should ideally have full access to appropriate curricula taught by qualified teachers who use suitable instructional resources that match each student's language and grade level. However, the unfortunate reality is that many schools cannot provide such support (e.g., bilingual instructional materials, individual tutoring support, time, and specific guidelines). Previous studies suggest that teachers' frustrations often originate from their feelings of helplessness and doubts about ELLs' ability to catch up with grade-level content (Penfield 1987, Reeves 2004). Thus, based on ELL education studies (Echevarria, Vogt, and Short 2004; Chamot and O'Malley 1994; Hurst and Davison 2005; Echevarria and Graves 2007), we suggest practical strategies that focus on increasing

- comprehensibility of texts and speech,
- interactions of ELLs,
- teachers' linguistic and cultural awareness, and
- collaboration and communication between ELL and content-area teachers.

While the following suggestions are neither quick fixes nor one-size-fits-all answers, it is our hope that they will help secondary science teachers better accommodate the needs of ELLs. These practical suggestions were adapted from multiple sources, such as the sheltered instruction model of Echevarria, Vogt, and Short (2004); Cognitive Academic Language Learning Approach (CALLA) of Chamot and O'Malley (1994); Hurst and Davison (2005); and Echevarria and Graves (2007).

Increasing comprehension

Adjust speech rate and enunciation. While English is a stress-timed language, many other languages, including

Spanish, are syllable-timed languages (Rost 2001). English tends to stress one or two syllables and slur the rest of the word or sentence, while each syllable of syllable-timed language (e.g., Spanish) tends to be equally stressed. This means that English sounds are often unclear to some speakers of other languages. Thus, pronouncing equally stressed words or sentences, along with adjusted speech rate, may increase students' comprehension. Additionally, longer pauses between the commas and periods in a sentence will help increase ELLs' understanding.

Introduce key vocabulary. According to Marzano (2004), teachers can help students build academic backgrounds by teaching key vocabulary. One strategy is to have students describe the terms, instead of define them. For instance, *asthenosphere* can be described as the hot, plasticlike layer of rock at the top of Earth's mantle that moves like an airport walkway. Its standard definition may be less accessible for ELLs: "An area of the upper mantle which begins around 100 km and extends to a depth of 350 km." Students can more easily visualize the description than the definition, the former of which can lead to deeper understanding of the term.

Use visual aids. One of the quickest ways to help ELLs understand science concepts is to show drawings, pictures, and instructional video clips (e.g., Discovery Education). When using instructional video clips, first provide an anticipation guide and avoid using a clip longer than 3–5 minutes.

Provide information or directions to tasks in both oral and written forms. Write down or present key concepts and vocabulary while you are explaining information verbally. Directions to some laboratory procedures lend themselves to graphic representations that should be incorporated into written directions.

Break down information, including directions, into sequential steps when presenting. Lengthy directions can be confusing. Provide steps to follow, preferably with bulleted points or visual cues.

Connect students' prior knowledge and experience to new knowledge. ELLs' prior science knowledge can be very different from that of native English-speaking students. For instance, some ELLs from tropical regions may have difficulty conceptualizing four distinct seasons. Provide opportunities for students to share what they already know. In doing so, students will be able to more easily connect new knowledge to existing constructs.

Use less text-dense instructional materials. Text-dense passages and handouts can overwhelm students and discourage them from reading. Use graphic organizers (e.g., diagrams, T-charts, semantic webs) for comparison and contrast, explanation of relationships, and description of characteristics. Commercially available graphic organizer software can simplify this task for teachers.

Present and teach from informal to formal forms of language. The following excerpt from Gibbons (2002, p. 40) illustrates how language can be developed from a less formal spoken form to a very formal written form (as in a science report) with the same concept:

- Informal: "We tried a pin...a pencil sharpener... some iron filings and a piece of plastic...the magnet did not attract the pin."
- Formal: "Our experiment was to find out what a magnet attracted. We discovered that a magnet attracts some kinds of metal. It attracted the iron filings, but not the pin."
- Very formal: "A magnet is able to pick up, or attract, a piece of steel or iron because its magnetic field flows into the pin, turning it into a temporary magnet. Magnetic attraction occurs only between ferrous materials."

Formal and decontextualized language typically presented in science texts and talk can increase difficulty in ELLs' comprehension. The major purpose of adjusting language levels is to make science content more accessible, thus increasing ELLs' understanding.

Teach learning strategies. Students need to learn how to use text features such as titles, subheads, pictures, drawings, figures, and graphs to gain information. These are skills that should be explicitly practiced in the classroom. In addition, it is critical to model how to inquire, discuss, present, summarize, and write a lab report through demonstration and display of concrete examples.

Use technology. Blogs, vodcasts, and podcasts can facilitate ELLs' self-study outside of the classroom. In particular, podcasts (audiofiles) recorded by the teacher or classmates allow ELLs to practice listening while developing an understanding of the science content. Vodcasts (videofiles) showing illustrations, pictures, and animations along with explanations assist students' understanding (Colombo and Colombo 2007). The widespread use of personal audio and video players increases accessibility of these modes of instruction.

Increasing interactions

Create heterogeneous group work. Group work is critical in that it increases students' interaction time and is less intimidating than talking in front of the whole class—therefore, students are more likely to speak up. Group work can also facilitate laboratory assignments and task-based science projects. Assigning and rotating specific roles to students in a group can encourage ELLs to participate in group work on a more equal basis.

Pair up a new or less advanced ELL with an advanced ELL (possibly the same native language) or a native-speaking student. Newcomers especially can benefit in various ways from this type of buddy system. Assigning specific roles to buddies can increase effectiveness of the buddy system. For instance, an advanced ELL with the same language background can explain task and assignment directions using his or her native language, while a native English-speaking student can help with notetaking.

Increasing awareness

Think like a linguist. Be mindful of and analyze the languages that you are using in the classroom as well as those that exist in the text and instructional materials. There are two types of languages used in the science classroom: science content–specific language and science content–relevant language. For instance, *chromosome, orbit,* and *gravitational force* are science content–specific terms, whereas, *hypothesis, theory,* and *prediction* are science content–relevant terms. Adjusting those terms to more understandable phrases such as "good explanation" or "what will happen next" will increase comprehension while keeping the meaning.

Think like an outsider. School and academic functions are cultural practices. The idea of thinking like an outsider will help you defamiliarize from what you are used to. For instance, classroom participation, asking for help from the teacher, and questioning grades are rooted in cultural practices. By raising your awareness of different cultural practices, you will be less likely to have trouble relating to students. As a result, you will be able to see what you may have taken for granted.

Increasing collaboration and communication with ELL teachers

Set up a regular meeting time if possible with your ELL specialist. This is almost as much an administrative issue as it is a pedagogical one. Administrators must be made to understand the value of continual collaboration over one-shot professional development. These meetings can serve as the avenue to address the issues related to ELL students. For example, you can discuss specific students' weaknesses, strengths, and progress with the ELL teachers and receive immediate feedback. In addition, these meetings can facilitate sharing the goals of each unit, instructional handouts, and assignments. In doing so, ELL teachers will be able to provide more responsive instruction in their ELL classes to support the work of content-area teachers.

Conclusion

Serving the needs of the growing population of ELL students and helping them to be academically successful is the shared professional responsibility of all teachers. By helping these students succeed, we increase our effectiveness as science teachers and make science accessible to all students, regardless of their national origins. ■

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