

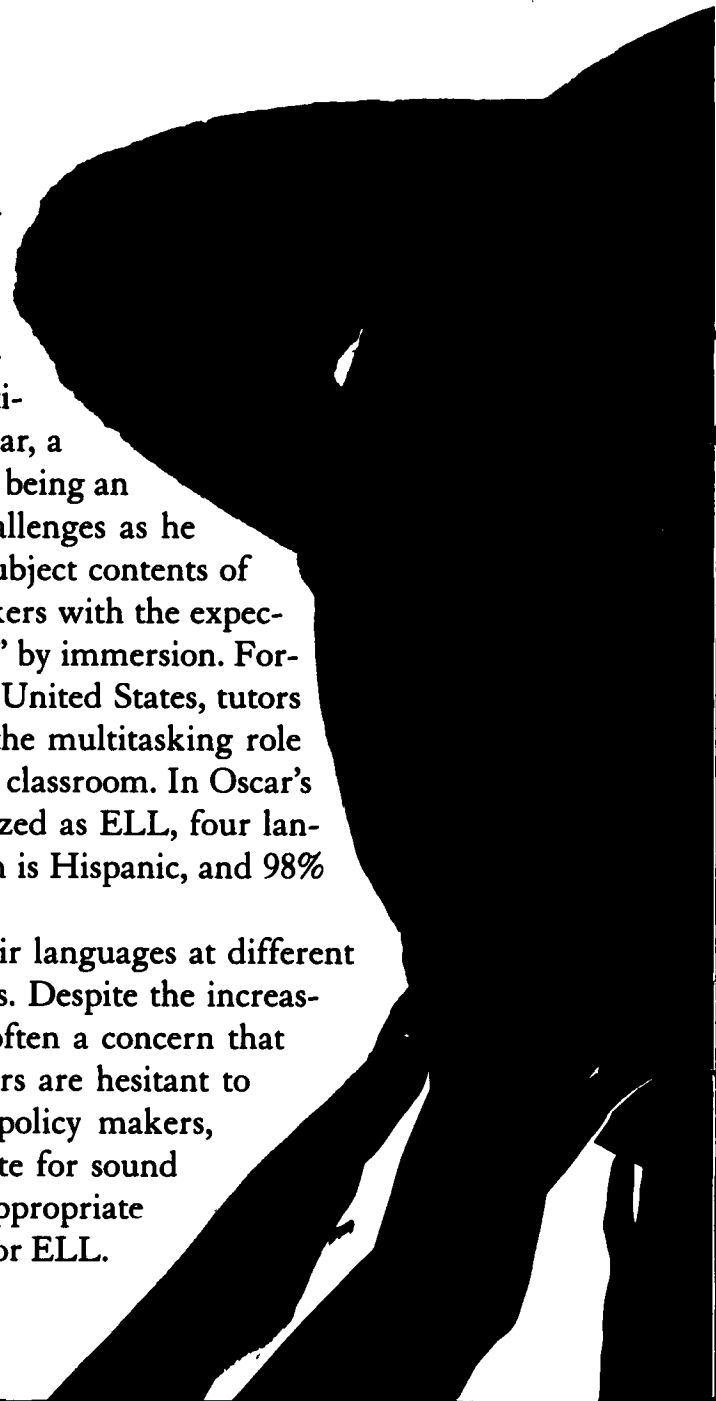
# Science for ELLs: Rethinking Our Approach

*Practical considerations and support for  
instruction of English language learners*

— William Medina-Jerez, Douglas B. Clark, —  
Amelia Medina, and Frank Ramirez-Marin

**M**any educators feel ill-prepared to meet the academic needs of students from culturally and linguistically diverse backgrounds. For Oscar, a 13-year-old Mexican immigrant in the southwest, being an English language learner (ELL) brings daily challenges as he tries to keep up with learning English and the subject contents of eighth grade. He takes classes with English speakers with the expectation that he will learn English the “natural way” by immersion. Fortunately, his older brother, who came first to the United States, tutors him in most areas. This helps Oscar cope with the multitasking role of being a nontraditional student in an American classroom. In Oscar’s school, 49% of the student population is categorized as ELL, four languages are spoken, 75% of the student population is Hispanic, and 98% of the students receive free or reduced lunch.

Oscar is bilingual. Bilingual students learn their languages at different ages, in various settings, and for unique purposes. Despite the increasing normalcy of growing up bilingual, there is often a concern that bilingualism hinders students in school. Educators are hesitant to incorporate language-facilitating methods. Yet, policy makers, school administrators, and educators are desperate for sound research and guiding practices to implement appropriate instructional materials and assessment strategies for ELL.



## Science for ELL

A rich amount of research suggests that native-English speaking and linguistically diverse students are equally capable of learning scientific concepts and terminology through collaborative inquiry-based experiences (Diaz and Flores 2001; Martin and Chiodo 2004; Reese and Goldenberg 2006; Simich-Dudgeon and Egbert 2000). The National Science Education Standards (NSES) promote "Education for All" through strategies that include: developmentally appropriate materials, implementation of instruction organized around inquiry, presentation of content relevant to students' lives, and building on prior knowledge of students (NRC 1996). Native languages represent a critical component to this prior understanding (Clark et al. Forthcoming).

Moreover, there is compelling evidence that not

allowing ELL students to use their primary language may hinder their academic competences and provoke negative emotional impact (Ovando, Collier, and Combs 2003; Valdes 2001). Practicing "additive bilingualism"—gaining competencies in a second language while maintaining the integrity of the first language and culture—enhances ELL students' educational settings by removing detrimental practices such as language subordination and education assimilation (Reese and Goldenberg 2006).

Inquiry-oriented instruction has been a guiding approach during the last 40 years (Hand and Prain 2006), meaning that students (including ELLs) are expected to acquire skills such as discussing, analyzing, reading, and writing in ways similar to those of a practicing scientist. If the goal of "Science for All" is to be accomplished, then we need to ask: (1) Are current practices working for students whose language differs from that of the mainstream group? (2) Are students acquiring school-only habits of thinking? (3) Are assessment strategies effectively showing what ELL students really learn?

### Recharting pathways

As educators, we strive to guarantee science education opportunities for all students. Although much remains unknown, current research provides us with crucial strategies to help ELLs in the science classroom. Here we look at possible issues in diverse classrooms and offer some ideas to provoke curiosity and confidence in ELL students.

#### 1. Encourage group work

One of the first things teachers can do is expose ELL students to peer language models and vary groupings by using mixed-level groups or allowing same-language partners. Teachers should accept peer translation and preferred languages within groups. Allowing groups to give oral presentations in both their primary language (L1) and English, their second language (L2), can create optimal opportunities to build on student contributions. Students may gain competency in learning a second language by a collaborative process in which they appropriate the language of interaction as their own, building grammatical, expressive, and cultural performance through this process (Slavin and Cheung 2005). In a cooperative learning context (including ELLs), each student is held accountable for the achievement of the task. One way to work toward this goal is by assigning roles to each person in the group (e.g., a recorder,

designer, or reporter, and so on). One example of a group activity project is described in the next section and involves students designing a food web. Such activities encourage meaningful contribution from each team member by providing opportunities to showcase individual skills.

## 2. Incorporate collaboration

Cross-curricular collaborations can be generated by involving other school professionals. For example, art teachers can help integrate diverse teaching and learning styles. ELL instructors can help science teachers understand ELL student needs and adjust instruction. Collaborative planning can also help teachers maximize and plan for multisensory approaches using props, outlines, visuals, sound, and motion to reduce linguistic abstraction and demands. Science lessons for ELL students should be hands-on whenever possible. The science curriculum can be structured to accommodate different learning styles. In the case of the group activity already mentioned, students are invited to create imaginary species as part of an activity to design a food web (Rockow 2007). For the activity, students are first introduced to the necessary vocabulary in a multimodal way—an ELL teacher could help with this segment—and then given a description of the novel species to be part of a food web. No geographical locations are excluded while students search for inspiration. At this point in the lesson, the teacher collects and redistributes a description of the imaginary species. Art teachers will be interested in promoting drawing skills as students use art to represent the organisms for presentation. Students artistically link their species to science concepts such as producers and herbivores. These strategies “not only motivate but also engage students in the reading process” (Elliot 2007, p. 27). Besides promoting excitement in most students, art requires learners to: (1) outline mental representations of the concept of the object depicted, (2) encode and decode information in ways that represent their own manner of seeing the world, and (3) self-evaluate the translations they have made of the written text (Elliot 2007).

## 3. Explicitly teach new vocabulary

Students can define terms in their own words, and draw and design mini-experiments to solidify new concepts. Teachers should give students the responsibility of presenting their ideas to the class in their chosen modalities, including nonverbal signals such as gestures, facial expressions, and other symbolic representations such as maps and graphs (Johnson 2004). Teachers should also encourage oral and written expression in combination with other creative communicative modalities in later presentations. Previewing and reviewing in languages other than English accelerates learning for ELL students. If the teacher is an English-only speaker, it would be beneficial for the teacher to request a bilingual classroom aide, invite bilingual volunteers to the classroom,

or encourage peer translations of content summaries. Perozzi and Chavez-Sanchez (1992) showed that bilingual students learned new vocabulary more rapidly in L2 when the words were first presented in L1. Perozzi and Chavez-Sanchez (1992) presented terms graphically while labeling in two languages, and later requested the students to verify learning receptively. Receptive acquisition was determined when the teacher observed three consecutive correct responses. This instructional mode can be achieved by setting aside direct time to work with ELL students on vocabulary and in conversation about their work while presenting visual information (e.g., designing a food web). Teachers could also represent new information to ELL students in the form of analogies. For instance, teachers can present students with representations such as “a chemical equation is like a recipe” (Orgill and Thomas 2007). Unfamiliar ideas (chemical equations and reactants) are associated with food practices from the students’ native countries and languages. Teachers can plan according to the cultures represented in the classroom. In the above-mentioned case, a teacher shared a recipe for traditional Brazilian candy (*brigadeiros*). Teachers should also remind students that analogies are strictly figurative when connecting terms such as ingredients and reactants. Making use of the students’ languages in printed resources (e.g., package labels, signs, and graffiti) celebrates the cultures represented in the classroom and extends the teaching and learning of science to environments beyond the school walls.

## 4. Use alternative assessment

Oscar, the high school student described at the beginning of the article, failed science exams consisting of vocabulary matching and short answers. For instance, when asked to define what an “insulator” was, he wrote: “...insulator is the wat [what] insulator [insulates] the house.” It is evident that Oscar used his previous knowledge, but because of language limitations, he was unable to earn credit for this answer. Implementing multiple forms of student assessment (e.g., portfolios, performance assessment, community projects, laboratory activities, and presentations) can be good indicators of students’ understanding in science. Teachers must insist that ELL students have access to dictionaries and time for translation during testing and assignments. Teachers who observed ELL students having difficulties on written assignments or exams have had success by assigning oral reports (Rockow 2007) or by teaming with those students to make testing more understandable by reading items aloud in a slowed rate, defining terms or giving examples to clarify items, and checking for comprehension, without necessarily giving the answers. For example, in our own experiences during lessons on light and the human eye, we were surprised to find a Spanish-speaking student well versed in science concepts in his native language, but guessing on multiple

choice questions in English about “near- and farsightedness” without knowing the meaning of the prepositions. The student gained understanding and correct answers when aided by a teacher’s simple gesturing of “far” versus “near” by hand distance and defining “sight” as “vision.”

### 5. Promote democratic classrooms

Listening with respect and attentiveness is a guiding principle to build a democratic community in the classroom (Hargreaves 1996). Teachers should try to accommodate ELL students during stressful moments and have the patience to hear all thoughts and questions that may be difficult for them to express. Adding personal relevance to science content can be achieved by drawing from students’ prior knowledge. If the goal is to have students interact with the curriculum in a familiar context, then the relevance of the program should be defined from the perspective of the student’s culture, not only from the authority of the discipline and the dominant culture (Aikenhead 2002). If possible, having diverse community members and college students from science-related fields visit the classroom offers a fresh perspective. Some school districts can afford to host international students. Students will show excitement about asking questions and relating to these mentors and classmates.

### 6. Include the contributions of non-Western scientists

One way to highlight the contributions of non-Western scientists is by having students conduct research about women and men of science from different backgrounds. This approach has been advocated by national reform efforts such as the NSES (1996) and the American Association for the Advancement of Science’s Project 2061 ([www.project2061.org](http://www.project2061.org)). NSTA’s position statement on multicultural science also calls for teachers to “incorporate the contributions of many cultures to our knowledge of science” ([www.nsta.org/positionstatement&psid=21](http://www.nsta.org/positionstatement&psid=21)). In doing so, the teaching and learning of science will conform to the principles of science as a human endeavor, the nature of science, and the way scientific inquiry is practiced. For instance, a practical way of organizing this activity is by having students choose a scientist and prepare a “Biographical Kit” (Phillon, Chamnes, and Lehman 2005) with artifacts representing major features of the life of the scientist, or reading excerpts about the life of scientists (from different backgrounds) whose contributions are important but whose names have been neglected or forgotten in the history of science (Medina-Jerez In Review).

### 7. Make sure preservice educators have diverse field experiences

Science teachers interested in enhancing their “multicultural competencies” (Wallace 2000) need models,

reflective practice, and knowledge-based information during methods courses and field training. Preservice teachers should read about specific practices to support ELLs, such as in the Sheltered Instruction Observation Protocol (SIOP) by Short and Echevarria (1999). Training should include lesson design for ELL students and role-playing that highlights the results of language barriers in instruction. Teachers also need language-facilitating strategies and feedback about enunciation, speed, and use of oral and written language. Strong multicultural preparation helps combat stereotypes created before starting a teaching career. One common stereotype is the *Pobrecito Syndrome* (*poor thing syndrome*) that refers to having lower expectations for Latina/o students (Rodriguez 2004). To avoid reinforcing stereotypes, teachers should build multicultural competencies from firsthand experiences with culturally diverse individuals and communities.

### 8. Use technology in the classroom

According to research by Clark et al. (Forthcoming), ELL students could especially benefit from programs that incorporate science content and language scaffolding with technology. In this research, ELL students freely switch audio and text languages (Spanish and English) as they explore curricular activities in online learning environments. Incorporating technology with multilingual scaffolding correlates to findings that the cognitive and social foundations needed for academic success are based in a student’s native language (Johnson and Swain 1997; Diaz and Flores 2001). Research indicates that when students interact in significant segments of instruction in their native language, their performance in English is also improved (Slavin and Cheung 2005; Clark et al. Forthcoming). Interactive tools, text-to-speech, voice output and visual information (i.e., diagrams, video clips) can add conceptual richness to any topic.

### 9. Encourage parent involvement

Students spend approximately five times as many hours in home environments than in school each year (Berliner 2006). Parents can be an important link between home and school contexts. Unfortunately, minority parent involvement is often hindered by logistical problems (transportation, money, child care) and communication barriers (Salinas-Sosa 1997). Talking to administrators about how to systematically overcome these barriers helps school communities find ways to involve minority parents. Parents could be invited to the classroom and outreach meetings. Some schools organize “parent’s night” programs in which students share science projects with their families (Brown and Friedrichsen 2006). Parent-to-student and parent-to-teacher workshops serve as an opportunity to facilitate information (in various languages) on science-related issues, such as health,

environment, and planning for careers in science. From the science classrooms, these issues can be part of relevant curriculum as students work toward being scientifically literate citizens.

### Initiate changes

A full understanding of how to address ELL issues during science instruction and assessment will require further study. However, this article has presented some key strategies supported by research thus far for providing ELL students with meaningful experiences in science. It may be long before we know all the answers about educating culturally and linguistically diverse children, but we currently know enough to initiate changes that promote learning for ALL students. ■

*William Medina-Jerez (wmedinaj@uwyo.edu) is an assistant professor in science education at the University of Wyoming in Laramie, Wyoming; Douglas B. Clark (dbc@asu.edu) is an assistant professor in science education and Frank Ramirez-Marin (Frank.Ramirezmarin@asu.edu) is a graduate research assistant in the Language and Literacy program, both at Arizona State University in Tempe, Arizona; and Amelia Medina (ameliamedina22@hotmail.com) is a speech language pathologist at STRIDE in Cheyenne, Wyoming.*

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