In 2008–2009, over five million school-age children (K–12) were identified as “Limited English Proficient” (NCELA), making up almost 10% of the entire U.S. public school student population. According to some estimates, English language learners (ELLs) could account for 25% to 40% of all students in K–12 schools by 2030 (Garcia 2002; Thomas and Collier 1997).

The growing number of students needing additional language support requires extra time in the hectic schedule of a typical science teacher (Bergman 2008; Hoover and Achilles 1996; Meek 2002). The good news for busy teachers is that several researchers and educators have crafted methods for using “sheltered instruction” to meet the unique needs of ELL students: “Sheltered instruction is an approach for teaching content to English learners in strategic ways that make the subject matter concepts comprehensible while promoting the students’ English language development” (Echevarria, Vogt, and Short 2007, p. 5). These techniques allow teachers to combine language development with science instruction. The bad news, or so it appears, is that sheltered-instruction strategies are another dish added to science teachers’ array of spinning plates.
Comparing sheltered ELL instruction and science inquiry

In part of a larger study that examined seminal documents of science and ELL education (Bergman 2010), fundamental strategies promoted in these two fields were analyzed for consistency. The goal was to determine the extent of agreement and how science educators can use them together for successful ELL student learning.

In science, the prominent strategies were found in inquiry-based science and its learning-cycle rendition (Bybee 2002; Colburn 2000; Colburn and Clough 1997; NSTA 2004). “Science as inquiry” is a primary thread in the National Science Education Standards (NRC 1996; 2000) and a core approach promoted in National Science Teachers Association position statements: “Scientific inquiry is central to the learning of science and reflects how science is done” (NSTA 2004, p. 2).

The source document of key sheltered instruction strategies for ELL students was the Sheltered Instruction Observation Protocol, or SIOP (Echevarria, Vogt, and Short 2007; Pearson 2008). Originally created as a classroom observation tool, SIOP is also a model for planning and implementing lessons: “The theoretical underpinning of the model is that language acquisition is enhanced through meaningful use and interaction” (Echevarria, Vogt, and Short 2007, p. 16). In the SIOP approach, ELL students develop their language skills while simultaneously learning subject content (e.g., science).

The findings of the comparison analysis were enlightening and encouraging. In nearly every aspect of instruction, time-tested and research-based strategies endorsed in science inquiry are the same as those outlined in SIOP’s model for ELL students. The Venn diagram in Figure 1 illustrates the amount of overlap found between strategies of sheltered ELL instruction and science inquiry. These findings should inspire science teachers who implement inquiry-based instruction in their classrooms: They already possess many tools to reach and teach English language learners. The following sections discuss in more detail common strategic elements promoted in both science inquiry and sheltered instruction.

**Content connected to students’ experiences**

In order to support ELL students’ reading comprehension and even word recognition, teachers must draw out and then build upon learners’ prior experiences, including personal memories, cultural upbringing, and firsthand encounters with content. Likewise, science instruction is most meaningful when students connect concepts to previous experiences, whether in or out of school. Current news or popular culture, cooperative work, discrepant events, and laboratory investigations are additional experience pathways. According to Colburn and
Clough, “Giving students direct experience with a concept before providing verbal instruction is critical in helping them relate the verbal abstractions to more meaningful concrete experiences” (1997, p. 30). Moreover, this constructivist-based approach can increase student engagement and critical thinking (Bolliger 2004).

**Meaningful and memorable materials**

Nearly half of SIOP’s components feature the use of visual or hands-on materials. Tangible, relevant items are also necessary for effective inquiry-based learning. Materials promoted by SIOP and science inquiry include hands-on manipulatives, realia (real-life objects), pictures and illustrations, models, graphs, charts, and multimedia resources such as videos, interactive software, and internet resources.

**Learning by doing**

Those who are fluent in a second language recognize the urgent need to practice and immerse oneself in a dialect in order to “stick.” Similarly, inquiry-based science labs require active student involvement and input: selecting investigative questions, applying math during analysis, defending findings, and reflecting on results (Clark, Clough, and Berg 2000). Teachers working with ELLs, science students, or both can ensure lasting learning when everyone contributes in the classroom.

**Opportunities for application**

The foundation of learning strengthens when students can apply new concepts and skills: “Application means using or recognizing previous ideas in a new situation” (Colburn and Clough 1997, p. 33). The same approach enhances language learning: “For students acquiring a new language, the need to apply new information is critically important because discussing and ‘doing’ make abstract concepts concrete” (Echevarria, Vogt, and Short 2007, p. 114). Application could occur via research projects, graphic organizers, journal writing, research and reports, field trips, and more.

**Student groups and interactions**

Application also involves interacting with peers in activities such as cooperative activities (e.g., Kagan strategies), role-plays, debates, discussion circles, and the teaching of others. Such interactions are appropriate in various contexts of learning, including science and language acquisition. In both cases, students have opportunities to use, review, and refine academic language and vocabulary.

**The teacher’s critical role**

Both SIOP and science inquiry disparage the traditional teacher-centered, lecture-dominated classroom. However, the teacher still plays a critical role to ensure successful student learning. Essential teacher behaviors include the following: (1) clear speech, (2) eye contact and welcoming gestures, (3) individualized interactions, (4) open-ended questions, (5) sufficient wait-time I (after teacher question) and wait-time II (after student response) so all have time to think, and (6) responses that encourage more student contributions (“Tell me more about…?”) and further critical thinking (“What do you mean by…?”) without excess praise or criticism.

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**FIGURE 2 Example content/language objective pairs (Short, Vogt, and Echevarria 2011)**

<table>
<thead>
<tr>
<th>Content objective</th>
<th>Language objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students will be able to conduct research on natural hazards.</td>
<td>Students will be able to write interview questions and response sentences in order to participate in interviews about natural hazards.</td>
</tr>
<tr>
<td>Students will make detailed scientific observations about characteristics of rocks.</td>
<td>Students will use vocabulary and sentence frames to explain their rationale for the selected categories: “These rocks are classified in this category because…”</td>
</tr>
</tbody>
</table>
**Time and student management**

In a student-centered approach advocated by both SIOP and science inquiry, teachers must be diligent in managing the classroom. Often, a well-managed environment is the by-product of fully engaged students. Teachers need to fill the entire class period with appropriate activities and relevant learning. This involves the “Goldilocks” principle: lessons must be just right—not too fast, not too slow, and not too difficult, not too easy. Therefore, it is imperative that teachers consider students’ unique needs and specific classroom contexts.

**Discrepancies between SIOP and science inquiry**

As depicted in Figure 1, not all strategies are a complete match. Two major discrepancies do exist. These are discussed below with recommendations for reconciliation.

**Discrepancy #1—Lesson objectives**

The first difference between sheltered instruction and science inquiry is in the format of lesson objectives. Science typically focuses on content (concepts, skills, etc.). The SIOP model splits objectives into two categories: content and language. Language objectives emphasize students’ development of one or more domain in communication—writing, reading, listening, and speaking (Gottlieb, Cranley, and Cammilleri 2007). Two kinds of objectives do not mean twice the work. Instead, science teachers can consider how learning content also affords opportunities for cultivating students’ language fluency. Figure 2 shows two pairs of content/language objectives designed for middle-level science—examples from SIOP training materials (Short, Vogt, and Echevarria 2011). Language objectives could be considered as further description of how students communicate or apply their science content knowledge. While content objectives emphasize the “what” students will learn, language objectives are the “how” students will display understanding. As science teachers prepare lessons, they can identify ways to include language development along with content mastery. Using a paired content/language objective approach emphasizes both aspects and benefits native English speakers, as well.

**Discrepancy #2—Overt outcomes and objectives**

The second difference between the two models of instruction lies in presenting the lesson objectives. The SIOP approach advocates deliberate, methodical attention to each day’s expected outcomes: “It is critical for [ELL students] to have instructions presented in a step-by-step manner, preferably modeled or demonstrated for them” (Echevarria, Vogt, and Short 2007, p. 81). This manner of front-loading lessons is in apparent disagreement with the speculative nature of science inquiry. During inquiry-based instruction, students should usually not be told the expected outcomes or even procedures for investigation. These open-ended facets are essential for authentic student learning of science concepts and processes.

Nevertheless, science teachers can seamlessly navigate the conventions of ELL instruction without sabotaging inquiry. The teacher can still clearly communicate the intended lesson outcomes (e.g., complete the investigation, determine what affects reaction rate, observe as many changes as possible) without revealing the actual content outcomes (e.g., what the students should find as a result of their investigation). In this way, students know what is expected of them but still anticipate science learning with a sense of discovery.

The content/language objective pairs given in Figure 2 are helpful examples of this approach to lesson outcomes. Notice that in both pairs, the topic and evidence of learning are clearly outlined (natural hazards, interview; classifying rock types, rationale sentences). However, the particular phenomena, findings, concepts, and applications are undisclosed and awaiting student investigation.

A final consideration is communication of lesson outcomes. The teacher should not just recite objectives during the opening minute of class. The timing should occur at a logical, meaningful moment in the lesson. This typically occurs near the beginning of class, but does not always need to be the first order of business. Bell work, review, a demonstration or discrepant event, grouping instructions, and other procedures are often necessary for providing structure and attracting students’ attention. Variety promotes student motivation and interest. Even so, consistency in expectations provides structure for all students, especially English language learners. When addressing lesson objectives (content and language), teachers can promote further student engagement by involving them in the task. Students can practice language by reading objectives out loud with each other, the teacher, in small groups, or individually. This requires
that objectives be written down, which also provides concrete representation to support student learning. Again, variety is effective where appropriate, but in most cases, students appreciate a consistent location for instructions. Displayed objectives and directions can appear at the front of the room on a whiteboard, bulletin board, PowerPoint slide, paper handout, or other user-friendly format. Such routines of explicit expectations and visual cues are helpful for everyone in the classroom.

Synergy and science for all

Science teachers using inquiry-based instruction are already familiar with many skills required for supporting ELL students. Nevertheless, teachers must be careful not to assume a quality content lesson is all set for English language learners. With review and reflection, they can consider what changes—often minor—are necessary for clear and meaningful instruction. This proactive habit is important to meet the needs of every individual in the classroom.

The strategies promoted by both ELL and science inquiry result in synergetic lesson plans. Rather than competing for time or attention, these pedagogical tools complement each other. Where discrepancies do arise, teachers should make adjustments to aid English language learners while maintaining the integrity of inquiry. In doing so, they will find that science for ELLs can truly be science for all.

References


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