

Science *as a* Second Language

*Verbal interactive strategies help
English language learners develop
academic vocabulary*



ART BY CHARLES BEYL

IN A SEVENTH GRADE SCIENCE CLASS, GROUPS of students are about to start an experiment. They are given small containers with water, straws, and various soap solutions and experiment with them by making bubbles. Through this experimentation, they try to find out why some bubbles burst as soon as they are blown while others float for a long time. The teacher suggests that students blow a bubble until it bursts, measure the circle produced by the bursting bubble, repeat the procedure several times, record their findings, compare the measurements recorded by other students, think of possible explanations for different findings, and discuss possible hypotheses (adapted from Cantoni-Harvey, 1987).

As is common in classrooms in the United States, this class has students whose first language is not English. Among these students, the level of English proficiency varies greatly. One student, Maria, is a recent arrival to the United States. In addition to her regular classes, she receives English as a Second Language (ESL) instruction three times a week for 45 minutes. Two other students in the class have passed the English proficiency test used in

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the school district and have recently been mainstreamed into all-English instruction classes.

The teacher is certain that Maria will be unable to participate in the science experiment, so instead of including her in the science activities he has planned, he sits her close to his desk and motions for her to practice the English alphabet on a worksheet. The other English language learners, Nalan and Mehmet, both born in Turkey, are placed in separate groups so they will not use their native language. After the class, the teacher wonders if he could have integrated Maria, Nalan, and Mehmet in the science activities so that they could develop scientific knowledge and academic language at the same time.

One of the best ways to teach the content and language of science to all students, including English language learners, is to engage them in activities that promote verbal interaction and collaboration, or “interactive science teaching.” In this classroom scenario, immigrant students such as Maria can and should be involved in laboratory activities early on in the English learning process. To accomplish this, the following recommendations can be adopted by middle and high school science teachers who have English language learners in their classrooms and who may or may not have support from an ESL teacher.



LANGUAGE AND CONTENT

Research suggests that both English language learners and native-English-speaking students learn science, its rhetoric, and its vocabulary best when teachers create activities and situations that allow them to be genuinely engaged in scientific inquiry through collaborative talk (Simich-Dudgeon, 1998). In addition, the use of familiar genres such as personal narratives, storytelling, and role-playing can be an effective link between English language learners' emergent English proficiency and the distinctive rhetoric and vocabulary of science.



Even science teachers who do not have specialized ESL training can develop awareness about the differences between the language and content demands of the science curriculum and the language and content knowledge of their students. English language learners can differ in their level of mathematical knowledge, which is important to consider because experimentation requires a good understanding of mathematics skills like counting, measuring, comparing, estimating, approximating, and solving equations (Cantoni-Harvey, 1987).

In addition, depending on their educational backgrounds, English language learners may lack study skills and may have low conceptual scientific understanding (Chamot and O'Malley, 1994). Experimentation, inquiry, and teacher modeling are effective tools for use with all students, particularly English language learners, because these techniques encourage them to negotiate scientific meanings through verbal interaction with the teacher and their peers.

Cultural differences may also lead English language learners to produce alternative hypotheses and interpretations than those expected by the teacher. Incorporating these students' cultural knowledge and experiences into science units and lessons makes the content easier to understand and more relevant to them. English language learners need opportunities to develop content skills such as observing, classifying, comparing, predicting, making generalizations from findings, and formulating and testing diverse hypotheses (Cantoni-Harvey, 1987).

Science teachers should be aware that English language learners, particularly those with no previous schooling or interrupted schooling, will have difficulty with the discourse, text structure, functions, and extensive vocabulary of science. Although these students may have developed the ability to communicate socially with peers and others in their homes and communities, their academic language skills may be far below grade level.

This lack of academic language is further challenged by science texts and tasks. This may be in part because science texts make it difficult for English language learners to identify the facts. For example, science texts develop concepts and skills through the use of argumentative, procedural, and descriptive genres and use different fonts, font sizes, colors, pictures, and graphic organizers to signal the organization and the importance of concepts and skills. Because these graphic elements involve so many signals, they can be confusing for those not used to them. In addition, the grammatical structure of scientific texts—frequent use of passive voice, sentences with multiple embeddings of dependent and independent clauses, complex noun phrases and structures like “if . . . then . . .” that indicate causality—may be difficult for students who are learning English (Chamot and O'Malley, 1994). Verbal interactive activities can help these students and their teachers overcome these obstacles and plan and participate in effective science learning experiences.

VERBAL INTERACTIVE ACTIVITIES

Face-to-face verbal interactions in the science classroom offer English language learners opportunities to negotiate science meanings; moreover, research suggests that talk is “a major means by which learners explore the relationship between what they already know and new observations or interpretations which they meet” (Cullinan, 1993, 2). Unlike English-speaking students who already possess valuable knowledge about the English language and its use, English language learners have English as “both a target and the medium of education” (Gibbons, 1998, 99). To facilitate the learning of English, these students need opportunities to interact with more competent speakers of English, such as the teacher and native-English-speaking peers, who act as language models for them (Simich-Dudgeon, 1998).

Verbal interactive strategies also support the *National Science Education Standards*, which emphasizes

“the inclusion of all content standards in a variety of curricula that are developmentally appropriate, interesting, relevant to students’ lives, organized around inquiry, and connected with other school subjects” (National Research Council, 1996, 7). These strategies allow learners to ask their own questions, incorporate personal elements into their work, and learn with and through peers. These activities can be used separately or as a whole in supporting the content and language needs of English language learners in the science classroom, and they can be adapted to fit different science curricula and texts.

INCORPORATING PERSONAL NARRATIVES

One effective verbal interactive strategy is the use of personal narratives. In this example, the teacher facilitates an inquiry project initiated by students asking about recent weather changes in their area. Based on the topic, a personal narrative activity like the one in the following scenario can help prepare students to find out more about the weather.

The teacher begins by telling a weather story from her life (“the time that the power went out during a storm” or “the hottest summer we ever had”) and modeling for students the narrative genre. To help English language learners comprehend, she uses a timeline to demonstrate the process of the story and incorporates photos, magazine pictures, and information from the Internet and other family members who shared the experience. During her narrative, the teacher asks leading questions along the way (What probably happens next? How do you think it ends? Why do you say so?) and gives students time to answer. At the end of the story, she relates the story to questions about science and asks students to formulate their own questions. For example, after the power outage story she asks, “How can we be more prepared for the weather?” and “Are weather forecasts ever right?” and after the “hottest” story she asks, “Why is it so hot in the summer?” and “How can we know what the weather will be?” She posts these questions and helps students to explore ways they could find the answers to these and other questions.

Next, the teacher encourages students to develop their own weather narratives and asks leading questions of those who need help coming up with an idea or event. Students working in small groups construct timelines and other graphical supports for their narratives. Students present part of their narratives to the class and let their classmates finish the story orally or in written form, then compare their endings to what actually happened. Together, students develop questions they have about the science issues raised during the narrative segments and begin exploring these issues.

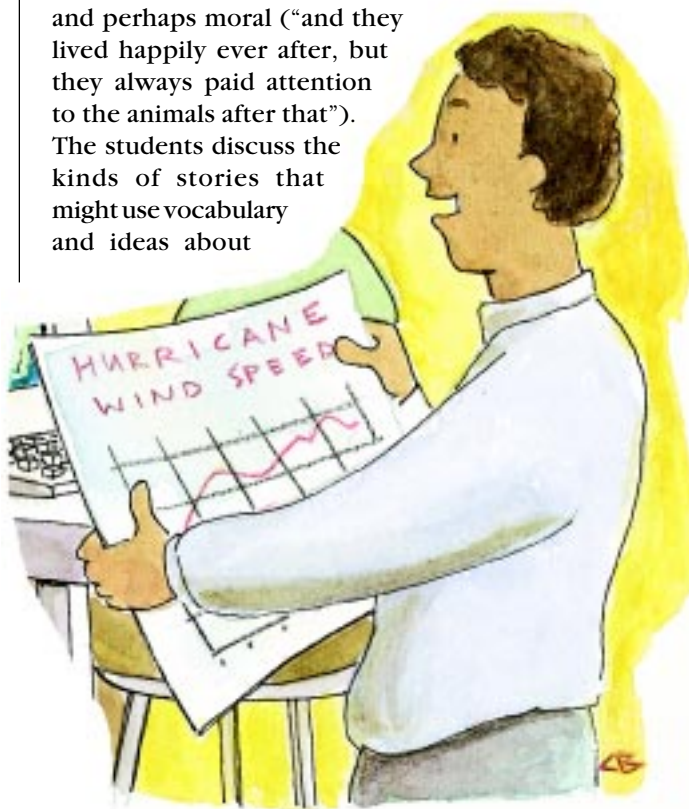
In this scenario, the teacher introduces content-based vocabulary in a personal and interesting context,

and she encourages her learners to ask questions and seek answers. Students are not only relating personal narratives but also are exploring science issues with their peers through a familiar genre.

SCIENCE STORYTELLING

As part of their exploration of weather, students can develop stories using the appropriate vocabulary to describe weather processes and their importance. This procedure is illustrated in the following scenario.

A teacher elicits information from the students and models the structure of a story, from the beginning (“Once upon a time”), through the chronologically arranged body, to the conclusive end and perhaps moral (“and they lived happily ever after, but they always paid attention to the animals after that”). The students discuss the kinds of stories that might use vocabulary and ideas about



the weather. Depending on linguistic competence and science knowledge, the teacher provides story starters for students who need them.

Working in small groups, students develop their stories. Within the groups, each student has a specific role to play, such as fact checker or secretary. A group may start its story, for example, “Once upon a time there was a sad weather forecaster. He lived in San Diego where the weather never changed much. He never got to call the Weather Service Forecast Station or the TV station or use maps from the National Meteorological Center. He was very bored.”

Students can post their stories around the room, read them to the class and answer questions, or compile them into a book. As students read their stories to the class, their classmates predict what comes next, provide

alternative endings to the stories, and check the science facts and language for accuracy. During the story construction, all the students use the vocabulary of the content area and negotiate story content. The dual focus on science vocabulary and storytelling structure helps English language learners to be involved in interactive science.

ROLE-PLAYING IN SCIENCE

Group work is crucial for integrating English language learners into mainstream classes and supporting verbal interaction in the classroom. However, groups and group tasks must be constructed with care to ensure that individual learners have the time, opportunity, and feedback needed to participate fully in the task. Role-play can support these conditions and promote the use of content-specific oral language.

To illustrate the use of role-playing, a teacher can help his students as they work in groups to develop a script for the weather units. For example, he tells students that a hurricane (or other weather event that occurs in the students' locale) is approaching. Students assign roles and responsibilities to each group member. One role-play might feature a television weather person (who puts the science terms in lay terms), the National Weather Service Forecast Officer (who constantly updates conditions), the local weather station manager (who relays the information from the national office to local organizations such as the police, fire, and news), a local organization representative, and a concerned local citizen.

Students work together to develop a scientifically accurate conversation that requires the participation of each group member. Students perform the role-play for the class, and the teacher debriefs the class by using discussion, written reflection, or other follow-up activities.

This assignment gives learners the opportunity to personalize the science content and internalize specific vocabulary items. The teacher has the opportunity to assess learners' understanding of the concepts and the language of the lesson.

INTERACTIVE SCIENCE ACTIVITIES

In addition to the activities detailed above, other general interactive strategies have proven to be effective in supporting all students' learning of science concepts and language (Chamot, 1985; Cantoni-Harvey, 1987) and are in keeping with the *National Science Education Standards*. Some of these are:

- Teachers can create Listening Centers where English language learners can listen to recorded class discussions and lessons. Students partner up to ask questions of each other and reflect on the listening task.
- During role-plays and other tasks, in addition to conveying meaning verbally, English language learn-

ers can demonstrate comprehension nonverbally through kinesics, pictures, music, visual organizers, and drawings.

- When English language learners respond to the teacher's science questions, students should be allowed to convey their thoughts as fluently as possible without focusing on their accents or grammatical errors.
- Teachers should provide ample opportunities for small-group interactions and brainstorming sessions.
- English language learners can share information with their peers by giving simple oral presentations.
- Teachers can design science Learning Centers where individuals or groups of students can engage in listening practice, science vocabulary expansion, and other content-related activities.

High school and middle school science teachers should include English language learners in interactive science learning, thereby increasing the opportunities for these students to learn science. Creating opportunities to interact within familiar genres such as personal narratives, storytelling, and role-play helps all students to learn the content and language of science. Supporting contexts that are familiar to them and tying science knowledge firmly to the students' lives provides opportunities for all students to improve their science literacy. ◇

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