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Science as a Second Language: Integrating science and vocabulary instruction for English language learners

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Integrating science and vocabulary instruction for English language learners

By Stephanie Wessels

Written on the chalkboard in the third-grade classroom are the vocabulary words *mantle, magma, erupt, shield, dormant,* and *lava*. In her science journal, Saida writes, "I think it is going to be about a volcano because of the words erupt, lava, magma, and people have to shield each other." The teacher circulates around the room while Saida and her classmates write prediction sentences in their science journals about what the upcoming science lesson could be about.

In recent years, educators have become ever more aware of the critical role that vocabulary knowledge plays in the academic lives of their students. Vocabulary knowledge is fundamental to the comprehension of text and is most effective when it relates new words to students' existing vocabulary and background knowledge. Effective vocabulary instruction provides multiple exposures through rich and varied activities that are meaningful and relevant to English learning (EL) students (Marzano 2004). This helps them gain ownership and understanding of the words, instead of just learning them well enough to pass a test. Nagy and Scott (2000) noted that "knowing a vocabulary word means being able to do things with it" (p. 273).

The principles of effective vocabulary instruction recommended for language arts can be applied to the content area of science. However, science instruction can be especially challenging for EL students who are faced with learning both the language of science and the English language at the same time. Even though EL students bring a wealth of cultural and linguistic knowledge with them to school, research has shown that these students tend to lag behind their native-English speaking peers in their levels of academic achievement (Echevarria, Short, and Powers 2006). EL students are less likely to have the vocabulary needed to comprehend informational text, so instruction that helps build both general academic and content-specific vocabulary knowledge is particularly critical while promoting language development.

Even EL students who appear fluent in English frequently need assistance in learning the academic language of science. The vocabulary of science can be particularly problematic. Words such as *work, table,* and *wave* take on meanings specific from those of everyday usage. Additionally, vocabulary words such as *hypothesis* and *analysis* have precise meanings in science that differ from the manner in which the words are used in everyday life (Powers and Stanfield 2009).

The goal of this article is to briefly discuss vocabulary instructional strategies and describe how they actively engage EL students in the science vocabulary learning process. Each vocabulary strategy offers students the opportunity to build and extend upon their understanding of a word's meaning and to make personal connections with the science content. Marzano (2004) suggests that vocabulary instruction is most effective when it targets academic terms that students will encounter throughout their reading materials.

All of the vocabulary words and concepts introduced throughout this article were taken from the district's science program for fourth graders. Even though the vocabulary words were selected from the textbook, these strategies can easily be used with informational books. Examples from the classroom experiences are used to illustrate each instructional strategy; however, all of these strategies can be used at all grade-levels.

Vocabulary Foldable

A Vocabulary Foldable (Herrera, Kavimandan, and Holmes 2011) is a concrete tool that allows students to continually record and process vocabulary learned throughout a 5E instructional lesson. Depending upon the number of vocabulary words highlighted in the lesson, the students take 4–5 sheets of different-color paper. The sheets of paper are layered on top of one another with the bottom edge of each sheet an inch above the bottom edge of the sheet under it. The sheets are folded in half, stopping where the same color meets, so that there are two layers of the same color in contact. The sheets are then stapled at the crease.

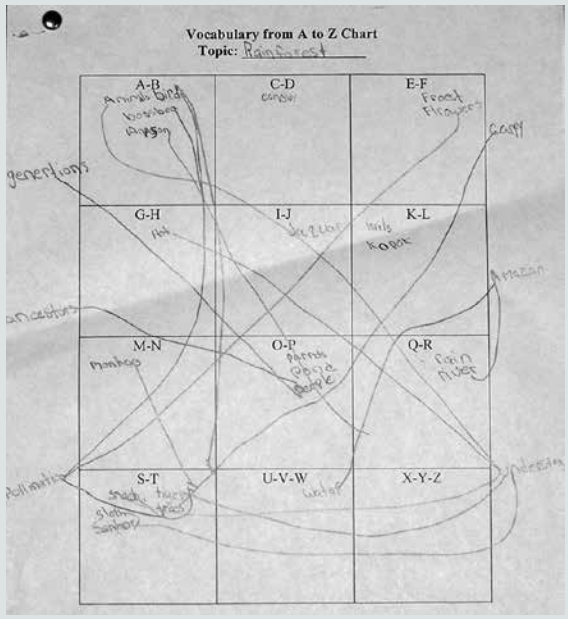
For example, a teacher wrote the vocabulary words *thunderstorm, tornado, hurricane, blizzard, and watch/warning* on the board during a unit on severe weather. The severe weath-

FIGURE 1.

Completed Vocabulary Foldable.

FIGURE 2.

Completed DOTS Chart.



er lesson connects to the disciplinary core idea of Weather and Climate for third-grade students, ESS2.D of the *Next Generation Science Standards* (Achieve Inc. 2013, p. 28; see Internet Resources). Once the students finished assembling the vocabulary foldable, they wrote each individual word on the top of each flap. Throughout the science lesson/unit, the EL students made notes using pictures and words to describe each vocabulary word when they came across it in the text and in classroom discussions (see Figure 1, p. 51).

In using the vocabulary foldable, students can elaborate on their understanding of academic language and connect their personal knowledge to the science content. This strategy can be very effective for EL students to make notes of particular concepts during the Explanation phase of the 5E instructional plan. The vocabulary foldable allows EL students to communicate lesson information, concepts, and vocabulary words in English. EL students are able to organize information related to key vocabulary and concepts and record their definitions using a hands-on resource that incorporates meaningful representations of their understanding.

DOTS Chart

DOTS is an instructional strategy that builds on students' background knowledge, encourages brainstorming and discussion, and at the same time visually displays the connections between background knowledge and the new words being encountered. In the DOTS strategy (Herrera, Kavimandan, and Holmes 2011), students fill in a chart with A–Z boxes, with each of the 12 boxes covering two or three letters of the alphabet (see NSTA Connection). Students write down all of the words they associate with the topic in the box labeled with first letter of the word. When the teacher introduces new vocabulary during the Explanation phase, students write the words along the outside of the chart. Students then make connections between these words and their activated background knowledge by drawing lines from the known information to the unknown vocabulary.

For example, students were studying about the rain forest, a connection to the disciplinary core idea of ESS3.C Earth's Systems for fifth-grade students (Achieve Inc. 2013, p. 45; see Internet Resources). Through the Earth and Human DCI connection, the students will be able to examine the cause and effects of climate change on the rain forest made by human activity. As an engagement activity, the teacher instructed the students to write down any previous connections or understandings about the rain forest. During the Explanation phase, the teacher wrote the following words on the board: *canopy, Amazon, ancestors, understory, pollination,* and *emergent level*. The students were instructed to write these words along the outside of the DOTS chart (see Figure 2, p. 51). After the Elaboration phase, the students were encouraged to draw lines from the words to any others associated with their existing knowledge. As the rain forest unit progressed, the students were able to continually add newly learned information to the DOTS chart.

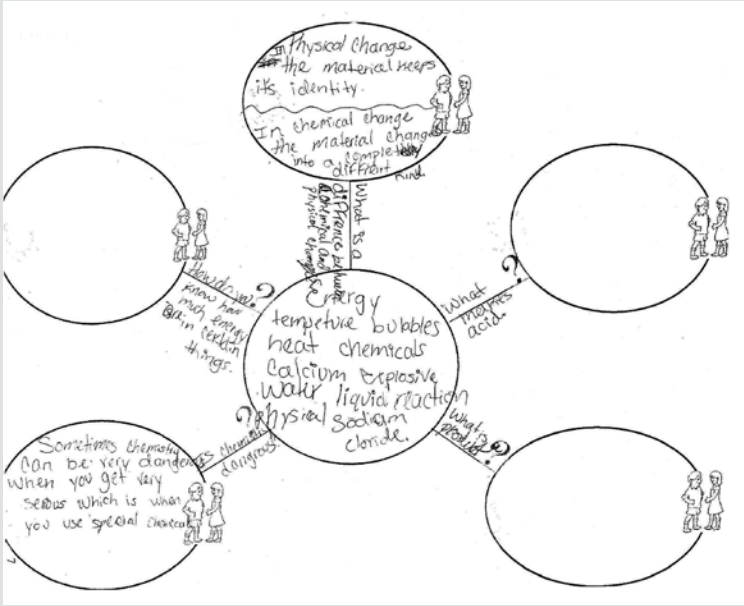
The DOTS charts provided students with opportunities to make connections and construct meaning through multiple exposures to the vocabulary throughout the 5E model of science instruction. The EL students are able to see how the scientific concepts and their original thoughts are more clearly connected. This helps to make the information more comprehensible and meaningful for the EL students.

U-C-ME

The U-C-ME strategy (Herrera, Kavimandan, and Holmes 2011) involves a graphic organizer tool that allows the teacher to activate students' background knowledge about the vocabulary or concept and generate questions about the new word (see NSTA Connection). The "U" in the strategy stands for "uncovers" as students uncover their existing knowledge about the topic. The "C" stands for the "connections" that the students make

FIGURE 3.

Partially Completed U-C-ME Chart.



with the topic and their existing background knowledge. The "ME" part is the final stage where the students have developed an academic understanding of the concepts they have learned. The U-C-ME strategy is similar to the KWL activity in which students first record what they know and want to know about the topic. However, U-C-ME chart is modified because the topic is located in the middle circle and the students' questions (what they want to learn) are placed on the line emerging from that middle circle. After reading, EL students are able to share ideas about what they learned from the text and class discussions to the circle that is attached to the question line.

For example, students were studying a unit on chemistry, a connection to the disciplinary core idea PS1.B Structure and Properties of Matter for fifth-grade students (Achieve Inc. 2013, p. 38; see Internet Resources). Through Structure and Properties of Matter DCI connection, the students will be able to establish a foundation of chemical reactions. The students activated their existing knowledge about chemistry in the middle circle on the U-C-ME template. As the teacher provided more introductory information about the unit, the students added vocabulary words into the middle circle. The teacher had identified several questions that she wanted the class to answer throughout the unit, such as: What is the difference between a chemical and a physical change? and What makes acid? Students wrote these questions on the question lines; on the rest of the question lines, the teacher had the students write their own questions that they wanted answered. One EL student included the following questions on his U-C-ME organizer (see Figure 3): Is chemistry dangerous? What is a product?

This summarization tool allows teachers to see how EL students interpret what is taught and read and then evaluate the accuracy of their interpretations, which can be part of the Evaluation component of the 5E model. This type of graphic organizer ensures that the questions are answered by the students and that information is chunked into meaningful and manageable units.

Conclusion

An instructional goal for science teachers should be to facilitate full participation of all students in the classroom and in all aspects of a rich science educational experience. According to the National Research Council (2012), it is important for students to use scientific and engineering practices such as revising and extending their explanations and evaluate their own knowledge and ideas. The vocabulary strategies discussed in this article offer EL students the opportunity to explore, evaluate, and extend the meaning of the words while developing a personal connection to them. Each of these strategies provides students with a concrete system for processing, reflecting on, and integrating scientific information and vocabulary around concepts that have been learned. In addition, each of these vocabulary strategies provides an opportunity for formative assessment where students can communicate their understanding of the learned concept.

These instructional activities enable students to expand their vocabulary, understand relationships between concepts, and learn through multimodal opportunities. They guide EL students to become actively engaged in thinking about the science vocabulary they are learning. By employing strategies such as these, educators can support EL students as they increase their scientific vocabulary knowledge and promote their engagement in the lesson. ■

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Internet Resources

NGSS Table: 5-ESS3 Earth and Human Activity
www.nextgenscience.org/5ess3-earth-human-activity

NGSS Table: 3-ESS2 Earth's Systems
www.nextgenscience.org/3ess2-earth-systems

NGSS Table: 5-PS1 Matter and Its Interactions
www.nextgenscience.org/5ps1-matter-interactions

NSTA Connection

For blank copies of the DOTS and U-C-ME charts, visit *www.nsta.org/SC1309*.