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Effective strategies for teaching science vocabulary

In order for students to develop scientific literacy, they need to gain a knowledge of science content and practice scientific habits of mind. This is impossible without knowledge of science vocabulary. This article shares research-based strategies for science vocabulary instruction that are effective for all students, including English language learners.

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Traditional science lessons have often begun with teachers presenting students with science vocabulary words and asking them to write the words, find the definitions in a dictionary or the glossary of the textbook, match the words to definitions, or use the words in a sentence. In this model of instruction, words are often presented in isolation and students are tested on the words alone, without application to concepts.

Many of us were "taught" this way, so we remember how little these practices contributed to conceptual development. These traditional strategies stem from the assumption that students absorb the meanings of many science terms simply by writing the words and their definitions. To many English-speaking students science words seem like a new language, and to English language learners, these words *are* a new language.

The job of science education is to teach students how to use thematic patterns of science to communicate meanings, "talking science" to solve problems in writing or speaking about issues in which science is relevant.[1] The goal of helping students learn to communicate about science is important, but we must also be aware of potentially harmful messages that can be unconsciously communicated to our students. As science educators, we not only teach science but we may communicate a "mystique of science" attitude, promoting the idea that science is authoritative, impersonal and humorless, lacking creativity or values. This communicates a view that scientists are "experts" or "them," rather than seeing ourselves as scientists.

Scientific writing and talk often project science as a description of the way the world works rather than as a human social activity that tries to make sense of the world. We instead should help our students learn that science is all around us, influenced by human uncertainties, judgments, values, and interests. It's important that we emphasize the human side of science. These well-established ideas about the nature of science[2] have a lasting effect on students, so we need to be sensitive about the messages we communicate. Science is creative and science is tentative, which means that scientists recognize that we understand things based on current research. Just think how our understanding of the world has changed as a result of the invention of telescopes or microscopes!

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Making sense of science

Science time in schools is often limited, and as a result teachers find it difficult to include science vocabulary instruction to help students make sense of text.[3] In addition, teachers are often eager to teach content, and consequently provide only a brief introduction of science terms.

English language learners have the added burden of trying to learn science in a language they have not yet mastered.[4] The increase of English language learners in schools has spawned research about elementary students and science vocabulary that focuses on ELL students and curriculum.[5] Many teachers mistakenly believe that ELL students must first learn English before learning science and fail to understand cultural influences on learning.[6]

Through hands-on inquiry instruction, all students can develop context-based content knowledge along with language development. Lee, Buxton, Lewis, & LeRoy identify inquiry-based science instruction as beneficial to students in the following ways: a) students participate in activities as they learn vocabulary, b) students work collaboratively and interact with others about science content, and c) hands-on activities offer students written, oral, graphic, and kinesthetic forms of expression.[7] Coupled with science activities, intentional and explicit vocabulary instruction can benefit both English proficient and ELL children's vocabulary and literacy development as they learn science content.[8] As students combine science experiences with discussions of words' uses and meanings, their vocabulary and content knowledge can grow.

In order for students to develop scientific literacy, they need to gain a knowledge of science content and practice scientific habits of mind. Knowing science vocabulary supports the development of these understandings.[9] As Wellington and Osborne point out, "science teachers are (among other things) language teachers."[10]

By using scientific terms and phrases during science activities, science educators can model scientific thinking and questioning, including the doubts and dilemmas that are part of making sense of the world. The more opportunities we provide for students to experience scientific endeavors, the more natural their scientific talk will develop. Teachers can maximize these opportunities by beginning with very young students.

Strategies for teaching science vocabulary

The suggestions in this article are designed to enhance science vocabulary development for English proficient students, students who depend on school to learn academic English, and English language learners. By using these strategies, teachers can begin to help all students engage in the language of science.

TIME TO TALK

It is important to promote students' dialogue as they have instructional conversations. We need to provide students with opportunities to use their colloquial language and translate back and forth with scientific and technical terms. We can use this strategy, called

regular K-12 classroom teachers an opportunity to plan lessons using the new NC Standard Course of Study for Limited English Proficient students known as the WIDA/ELP Standards.

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interlanguage, to discuss the different explanations of the students' experiences in the classroom. For example:

- Student: "We put this smooth powder in the bag along with the crunchy powder and the bag blew up and got hot."
- Teacher: "We mixed baking soda and calcium chloride with water resulting in a gas, and heat was released."
- Scientist: "The combination of baking soda and calcium chloride is an exothermic reaction with the products of sodium choloride, calcium carbonate, and carbon dioxide."

GIVING INSTRUCTIONS

We can support students' information processing by supplementing auditory information with visual clues. When we can provide students with multi-sensory experiences observing and communicating, it helps all students, especially emerging readers and English language learners. Instructions should be given using a variety of visual or aural support materials:

- drawings, diagrams, and pictures to support the spoken word
- written instructions on word cards or SmartBoard along with verbal instructions
- set-up examples to supplement written lab instructions
- audiotaped instructions alongside written directions
- pictures with words in stages of lab procedures that students can sequence

READING SCIENCE TEXT CARDS

Text cards help students interact with words and their meanings. Teachers can create science text cards by writing statements about science concepts on index cards. Working individually or in small groups, students discuss the statements before sorting. A number of different formats can be used:

- **True/false cards**. These cards include statements drawn from the text. Students sort the cards into true and false piles. For example, when teaching a unit on plants, use statements such as: "Plants use light from the sun in the process of photosynthesis" (true), and "Plants must depend on animals for food" (false).
- **Agree/disagree cards**. This format works well for more value-laden or controversial topics. One statement (including appropriate vocabulary) is written on each card. Students sort the cards into three categories: "agree," "disagree," or "not sure."
- **Matching pairs**. Students are given a stack of cards and asked to match a term with its associated function, symbol, scientific name, etc. For example, a stack might include cards with the names of body parts and other cards that name the body parts' functions. Students match each part to its appropriate function. Other topics for matching pairs could include:
    - parts of a device and its function (e.g. simple machines)
    - types of teeth and their functions for classification of animals
    - common name and scientific name
    - material and its common use
    - technical term, meaning, image

    - chemical name and symbol
- **Sequencing**. For cyclical concepts like the water cycle or the seasons, create one card for each stage in the cycle. Have students arrange the cards in a circular formation to represent the stages of the cycle. Examples include:
    - egg, larva, pupa, adult
    - spring, summer, fall, winter
    - evaporation, condensation, precipitation, accumulation
- **Classification**. Make a set of index cards naming vertebrates, for example, and another set with characteristics of each group — one characteristic per card:

Vertebrate	Characteristics
Birds	feathers, beaks, lay eggs
Reptiles	scales, cold-blooded, leathery eggs
Amphibians	cold-blooded, life cycles on water/land
Mammals	fur, warm-blooded, mothers provide milk for offspring
Fish	gills, cold-blooded

  These cards can be used in two different ways: 1) Pass out one card to each student, and have them find the other students who belong in their group. 2) Mix up the cards and have students work in small groups to sort the characteristics into the appropriate groups. Additional examples for this strategy include:
    - simple machines and examples of each
    - insect orders and characteristics of each
    - ecosystems with plants and animals that live in each

WORD LISTS/WORD BANKS

Many teachers use word walls to provide visual clues to words introduced in class. It's also important for teachers and students to *use* the words as much as possible. Students can look at the written words as teachers use them during class discussions, and teachers should encourage students to use the language of science in their verbal and written communication. Work with students to group words by their features:

- **Procedure words**: compare, describe, investigate, test, recognize, alter, minimum, similar, same, size, support
- **Opposites**: strong/weak, long/short, fast/slow, soft/hard, cool/heat, cold/hot
- **Movement words**: slide, travel, roll, slow down, speed up, accelerate, sink, float

WORD GAMES

Traditional games can be adapted to help students experience the language of science. For advanced students, making their own games using science vocabulary promotes in-depth understanding of words and their meanings.

- Hangman
- Odd One Out
- Charades
- Bingo
- Scrabble

- Trivial Pursuit
- Pictionary
- Dingbats
- Twenty questions, Who am I?
- Breaking words down into smaller words. For example:
    - invertebrate — in, brat, tea, tear, rate, vertebrae…
    - photosynthesis — sit, sin, thesis, photos…
    - temperature — rate, temper, rut, tear, ate…

WORD PARTS

Teachers can reinforce the structure of words as students identify and interpret prefix, suffix, base word and their meanings:

- **photosynthesis** — photo (light), synth (make), isis (process)
- **metamorphosis** — meta (large), morph (change), osis (process)

MULTIPLE MEANING WORDS

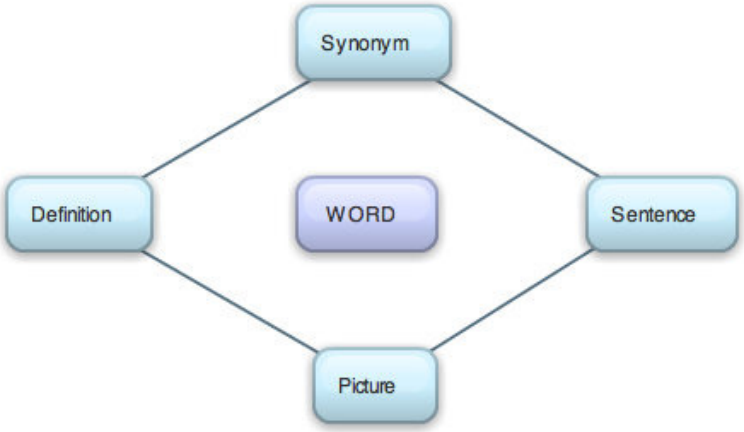
Words with multiple meanings can be confusing for students proficient in English and are especially troublesome for English language learners. It is important to discuss these meanings with students. When we confuse common definitions with meanings used in science, students' understanding suffers. For example, in common use, "theory" means a hunch, while in science, a "theory" is a well-established explanation of the natural world based on solid empirical evidence. "Reflections" are commonly thought of as thoughts or musings, which contrast with "reflections" of light rays. Many other words appear in both scientific vocabulary and in everyday speech, including:

- matter
- observe
- variable
- conductor
- conservation
- living
- volume
- balance
- receiver
- communicate

Work with students to identify the different meanings and applications of words with multiple meanings.

GRAPHIC ORGANIZERS

When students interact with science words in multiple ways, they are able to approach words and their meanings more fully. Graphic organizers can help to present words with a range of contextual information.



This graphic organizer provides a template for presenting a vocabulary word with contextual information.

ADDITIONAL STRATEGIES

The following strategies regarding vocabulary instruction were designed for English language learners, but are helpful to all students.

- **Use *lots* of pictures and labels.** The use of visual reinforcement supports comprehension and retention.
- **Teach definitional information** When you read definitions with students, be sure they understand how to read pronunciation keys, parts of speech, etc.
- **Use repetition.** Repeating words as much as possible helps clarify pronunciation and provides opportunities to transfer words from working memory to long-term memory.
- **Present words in multiple contexts.** Expose students to vocabulary words often, and in various contexts. This gives students a model for how words are used appropriately.
- **Use direct instruction of word learning strategies,** including structural analysis. In structural analysis, students examine the component parts of a word — e.g. the root word, suffix, and prefix — to determine the word's meaning. Teaching students this strategy can empower them to decode unfamiliar words.
- **Conduct collaborative group work.**
- **Build on students' prior knowledge.** An important part of this is identifying students' misconceptions and addressing them.
- **Engage students in instructional conversations.** In instructional conversations, students have discussions with other students and the teacher on topics that are relevant and have meaning to them. The goal of this student-centered technique is not to get correct answers to test questions, but instead to explore ideas. (For more on instructional conversations, see "Defining Instructional Conversations" by Professor Julia Scherba de Valenzuela of the University of Mexico.)
- **Integrate technology into your instruction.** It is helpful to engage students — particularly ELLs — with a variety of visual and aural alternatives. The use of technology can help to reinforce word meanings and provide students with multi-sensory connections.

- **Encourage "science talk" brainstorming.** Provide students with opportunities to brainstorm ideas about science and encourage them to wonder and talk about the natural world. For example, teachers can help students learn about the process of science classification. Provide students with sets of objects with varying features like buttons or dried beans and ask students to work in small groups and discuss properties for grouping the objects. When groups share their categories with each other, students have an opportunity to experience "science talk."
- **Limit traditional vocabulary instruction.** Traditional science vocabulary instruction, in which words are taught in isolation, is not conducive to conceptual development.
- **Pair students with peers during reading.**
- **Use active voice when introducing or discussing concepts.** ELL students understand active voice better than passive voice. "Animals use oxygen," for example, rather than "Oxygen is used by animals."

TOWARD A SHARED VOCABULARY

While there are many more strategies for helping students learn and use science vocabulary, this initial list provides a starting point for combining science content and vocabulary instruction — and a way to avoid falling back on traditional vocabulary instruction practices.

It takes concentrated effort to fit even more time for science instruction into a school day. Modeling the use of vocabulary words throughout instruction not only reinforces students' comprehension, but it also maximizes teachers' instructional time. I try to audio record myself on regular basis as a self-check of my vocabulary use during instruction. In addition, gestures, dialects, intonations, semiotics, and norms specific to children's cultural experiences, especially English language learners, can positively affect student learning.[11]

Additional research-supported strategies help build depth of vocabulary knowledge and foster word consciousness.[12] Asking students to predict the meanings of words and compare their predictions with other students and the teacher can strengthen learning. Interdisciplinary approaches that blend literacy lessons with science can also support science literacy.

Additionally, teachers should expose students to various forms of reading and listening to text as we provide opportunities for students to use words in speaking and writing.[13] Vocabulary instruction is effective when it includes visual, verbal, and physical support; therefore, physical scaffolding is critical in content-area teaching. Teachers' uses of nonverbal gestures or graphic representations convey understandings of science concepts and are beneficial for all students, including culturally and linguistically diverse students.[14]

It is important for young students to recognize the value of science vocabulary used in discourse. Sutton described the path of initial communication among scientists in history such as Faraday or Darwin that began with very personal statements such as, "I am starting to think about…" or "I seem to wonder…" in letters to colleagues. Sutton laments the skewed view of science when it is presented to children as cold and static facts rather than a dynamic discussion of wonder.[15] According to Wellington and Osborne, "Learning to use the language of science is fundamental to learning science."[16]

When teachers and students share science vocabulary, we learn to communicate while doing science.

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