

English Learners and the Science Curriculum

Introduction

Public schools in California contain the most diverse, challenging, and promising student population in the country. California serves more students in the public school system than any other state in the nation. In 2007, a little over 6.2 million students were enrolled in public schools (CDE Dataquest) compared to a little over 4 million in 1980 (CDE Archives). In addition to this giant leap in public school enrollment, students that are members of ethnically and racially diverse groups have made a dramatic shift in California during this same period. Ethnically and racially diverse students made up 44 percent of the student population in 1980 (CDE Archives). In 2007, this group represented 71 percent, making California's student population the most diverse in the nation (CDE DataQuest).

Combine these statistics with the fact that approximately one-fourth of California's students are English learners, special education enrollment has increased 88 percent in the last 27 years (CDE Archives), and over 50 percent of our students qualify for free and reduced lunch programs, teachers in the Golden State need to be both knowledgeable about science and skilled in meeting the wide variety of their students' needs (CDE DataQuest). Science education must develop future citizens who understand the physical world, apply this knowledge, and use scientific reasoning in multiple contexts to help solve everyday problems.

English Learners

The science program at all grade levels plays a pivotal role with English learners both in the development of scientific literacy and English Language Development (ELD). Through effective standards-based science teaching attuned to the stages of learning English the science program can provide a language-rich environment where English learners can create and express new understandings. Science teachers who are able to connect to these students are successful in communicating that students are not alone in their struggle to participate, that support is available, and that former English learners have succeeded in the science program. Equally important, on the part of the instructors, is the outward recognition that the English learner population is diverse. Instructors should take a positive approach to meeting the needs of English learners and demanding science content knowledge, academic English, and career goals for their future.

All science instruction tailored to students learning English as an additional language is informed by the following principles:

1. **Investigation and experimentation provide language development and scientific experiences.** In other words, it offers an arena in which the English learner can try out their maturing ideas about scientific phenomena using their expanding second language skills. It is only through expressing oneself about "something" that another language adheres to our lives and becomes part of our identities. Science content becomes that "something." What is learned in science through English remains as part of one's understanding of the universe and represents a step in one's growth into a second language. Thus, the student who plans, plants, observes, and records growth of her garden in English brings purpose

and significance to both life science and all English language development skills.

2. **There is a direct correspondence between the steps in the scientific process, with its incremental demands for an ever-expanding vocabulary and literacy skills, and the levels of English language proficiency contained in the California ELD Standards.** Throughout the process, the student's goal is to use contextually appropriate language that is accurate, precise and objective. For example, the oral or written descriptions of experiments expose English learners to a sequence of steps different in presentation style from other listening and reading experiences. Language structures expressing causal relationships need to be understood, tried out, and eventually incorporated into the linguistic repertoire of English learners.

A high quality science program for English learners exhibits the following characteristics:

1. **Planning science instruction, teachers capitalize on the advantages of teaching content to develop scientific concepts and academic language.** A hands-on science classroom can be a rich, highly motivating language laboratory. The key to building on English learners' experiences and leading them to reading and writing about science is engaging them in purposeful, guided instructional conversations about their lessons.
2. **The program incorporates oral instructional conversations in order to move English learners from personal experience to academic English, from detailed oral expression to factual writing, and from a superficial to a deep understanding of science.** Teachers and their English learner students form a partnership through guided conversations in which the students gradually appropriate the language of the discipline and use it to express their understandings. Teachers move English learners along a continuum of oral social English to the school world of written language, from inter-personal talk to school valued expository text. Teachers are skillful at signaling a need for clarification of English learner talk and providing clues for modifying their language. English learners, not teachers, restate their words in more academic terms. In effect, teachers are stretching student language to conform to conventions of the discipline. English learners take responsibility for making themselves understood to teachers who are motivated and interested in developing effective speakers who can describe, explain, question, hypothesize, and persuade. Instructional conversations represent a rehearsal for scientific writing in lab reports or science journals.
3. **Significant time is dedicated to science vocabulary development as English learners progress through the levels of English proficiency from "beginning" toward "advanced."** During science instruction, English learners must rely on their second language vocabulary not only to understand concepts, but also to generate written explanations of their readings, experiments, and observations for themselves, their teachers, and fellow students. Higher levels of academic achievement accompany an ever-expanding vocabulary for English learners. At this stage in their science study, vocabulary principally from Greek and Latin roots can represent a significant challenge. Science reading materials become more complex,

technical, abstract, and beyond students' social experiences. Extensive reading of science materials, however, provides exposure to Greek and Latin-based words, richness not generally found in oral language.

4. **Teachers dedicate time to teaching the characteristics of written scientific language.** The textbook provides the student with a written reference full of colorful illustrations, charts, and graphs; yet, because the text assumes proficiency in academic English, it is obvious that the English learners will not derive the same benefits from the textbook without teacher intervention and guidance. The factual and direct style of scientific writing can be dull, impersonal, and decidedly harder to understand than narrative fiction. The English classroom, where the most direct teaching of language occurs, rarely exposes the English learner to expository writing with complex content. In the science textbook, content is often unfamiliar, and new vocabulary is introduced rapidly and constantly. Details are usually presented before general ideas and concepts. Dense passages require rereading. There may be infrequent repetition or restatement of information. There is an emphasis on processes, interpreting diagrams and graphics, and understanding cause and effect relationships.
5. **Primary language support is used as appropriate for English learners at various levels of proficiency development.** Depending on the instructional objectives of the program, primary language utilization ranges from classes taught in the other language to the use of bilingual instructional assistants, to purchasing bilingual dictionaries to including other language editions of the textbook and tests. The appropriate grouping of students with a common primary language often facilitates the inclusion of primary language support.
6. **Attention to scientific discourse patterns is crucial in getting English learners to recognize and understand the differences between expository text and narrative.** Students need to get practice reading, listening to the material, and using such common linguistic structures as "if _____, then _____," linking words such as "then," "next," "finally," "after," the explanation of events or phenomena using a logical sequence, or the inclusion of a concluding statement in oral and written reports.
7. **Use of additional supplemental instruction, to strengthen English learners understanding of major concepts or to link their prior experiences to new science classroom experiences, is frequently suggested.**
8. **Assessments focus on what students have learned through carefully structured written and oral tests in which language is not a barrier to student response.** Students need to be taught to take advantage of and use all the information presented to them.

Helping English Learners in the Science Classroom

For English learners, school can be a frustrating and potentially overwhelming experience. In school, these students are faced with the challenging task of learning content while simultaneously acquiring English.

Science texts and discussions are filled with obscure vocabulary, which is often difficult for native speakers to master. Understandably, English learners also often struggle with the language of science. This difficulty is not to be confused with an

inability to think scientifically or to apply the scientific method. In some cases, English learners may come from a strong science background, but they may not be able to transfer their learning due to the language barrier (??citation??). Fortunately, there are many strategies for helping English learners succeed in your classroom. Many of these strategies are also effective for differentiating instruction for other students in the classroom.

Planning For Success

Effective science teachers use a variety of methods to help students understand detailed, often complicated, scientific processes. Teaching English learners requires a similar approach. Consider the following strategies as you plan future lessons:

Utilize and share lecture outlines. Outlines can help English learners remain focused and in step with the lesson.

Communicate using many formats. Graphs, charts, and figures that do not rely primarily on written or spoken language to convey information can be extremely helpful. Layout of visual aids should be clear and uncluttered.

Focus on key science terms. Use short, less complex sentences to teach and reinforce important vocabulary before, during, and after the lesson.

Make use of students' background knowledge of science concepts. Attempt to discover what English learners already know about a given topic and build upon it.

Have students identify familiar terminology. Many science terms are used internationally. Ask students to inform you when they recognize this type of vocabulary.

Assign group projects to help English learners master concepts. Project work provides opportunities for exchanging ideas, researching, writing, and presenting. Using a variety of skills can increase understanding and retention.

Creating a Positive Science Classroom Environment

Students who are learning English may be reluctant to participate in classroom discussions and activities. A positive, supportive environment has a tremendous impact on student comfort level, motivation, and success. These strategies can make your science classroom a more inviting place for students with limited English proficiency:

Establish consistent science classroom routines. When specific activities proceed in similar ways each time they occur, students are freed to concentrate on content rather than trying to determine what will happen next.

Increase peer interaction. Compose lab groups with care. A student who is learning English might benefit from being partnered only with strong English speakers.

Based on the skill and confidence of the individual student, adding someone to the group who could assist with translation might be appropriate.

Develop meaningful, relevant tasks in which students utilize science tools.

Hands-on activities provide a forum for success for all students, regardless of language ability.

Consider your seating plan. Students with limited English proficiency might benefit from sitting closest to the instructor, to a student who might assist with translation, or to a particular classroom resource.

Increasing Opportunities for Communication

Science is rarely done in isolation. It requires discussion, sharing of ideas, and frequent communication. Providing opportunities for learning in this manner will help students who are learning both English and science content. Consider the following strategies for increasing communication:

View lab time as an opportunity for one-on-one communication. As you move about the room, speak individually with students. Ask questions about what they are doing and learning in the lab activity, and devote time to listening to their responses.

Increase opportunities for informal dialogue. The more opportunities an English learner has for informal conversation, the more quickly he will master the language.

Allow adequate wait time. While the correct answer to a question may quickly occur to an English learner, translating thoughts to English and formulating a reply will take longer. Be patient. Resist the temptation to finish a sentence or supply a word for a student who is making an earnest attempt.

Model science language. When a student uses a term incorrectly, incorporate it into a sentence to demonstrate appropriate usage. Provide positive reinforcement when a term is used correctly.

Use normal volume and pace of speech. Speaking loudly does not increase comprehension for English learners. Measure speech, particularly when introducing new vocabulary or concepts.

English learners speak to a group when they are ready. A student will speak up in class when he or she is ready. Allow for other modes of participation, and other opportunities to speak.

Managing Safe and Productive Laboratory Exercises

Lab work requires a high level of understanding between student and teacher. Increased independence during laboratory exercises raises issues of both safety and comprehension. The following strategies can increase the safety and effectiveness of lab activities:

Develop clear procedural steps. Consider using flow charts and pictures to outline steps of the procedure. If written, use consistent terminology, introducing as little new vocabulary as possible.

Begin lab activities as teacher demonstrations. Model procedures that are new for students or may cause confusion.

Define key terminology in lab procedures. Misunderstanding of new vocabulary should not result in performing poorly during lab activities.

Begin with lab exercises that use non-hazardous chemicals, procedures, and equipment. Giving English learners the opportunity to build confidence will increase their chance of success and decrease your need to be overly protective.

Provide a pictorial guide on the materials table. A visual reference will help students successfully manage chemicals and equipment.

Teach safe laboratory procedures using a variety of formats. Demonstration,

multimedia, and graphics can be used to communicate information about lab safety.

Display safety symbols. Safety symbols should be posted throughout the lab, as well as in appropriate locations on lab handouts.

Science is an International Language

Teachers of limited English proficient students must keep in mind that true science is not any specific content or terminology, but an approach that can be taken to solving any problem encountered. Help students understand that science involves questioning, gathering and analyzing data, and communicating findings. This is as important as helping them acquire content. As students master the intricacies of the English language, their confidence in mastering the language of science will also grow.

Assessing English Learners and Special Needs students Inclusiveness of Assessments

The principles of universal design help to make assessments accessible to all students. The application of universal design principles to the development of classroom assessments will: (Thompson, Johnston & Thurlow 2002)

- Allow for the widest range of student participation, including students with disabilities and English learners
- Ensure that the assessments themselves are not obstacles to improved learning
- Provide valid inferences about the performance of all students
- Provide each student a comparable opportunity to demonstrate their understanding of the content tested

The seven elements of universally designed assessments include:

1. Inclusive assessment population—addresses the context of the entire student population to be assessed. California classrooms include students with different cognitive, cultural, and linguistic backgrounds. These students represent a wide range of skills, abilities, and diverse learning needs.
2. Precisely designed construct—recommends that all assessments are designed to measure what they intend to measure. Formative and summative assessments at all grade levels need to closely align to the intent and content of the standards.
3. Accessible, non-biased items—maintains that all items used in classroom assessment are not biased against any groups of students.
4. Amenable to accommodations—addresses the use of appropriate accommodations during testing. While experts maintain that universally designed assessments will be accessible to most students, some students will still require accommodations. These accommodations can include: alternate settings

(alternate rooms, non-school settings, special lighting, furniture, and/or acoustics, other school personnel); scheduling and timing (to correspond with medical or learning needs, short breaks, extended time); presentation formats (Braille, large print, signing directions, translation, underlining words/phrases, visual magnification or reduction, acetate shields); and response formats (use of word processor, typewriter, computer, adult transcription, Braille, student dictation).

5. Simple, clear, and intuitive instructions and procedures—maintains that students should respond to a task in the manner that the test developer intended. Regardless of a student’s ability, language skills, knowledge, or experience, test directions and instructions need to be simple, clear, consistent, and easy to understand.
6. Maximum readability and comprehension—focuses on the use of vocabulary and sentence complexity appropriate for an intended grade level. Research is showing that linguistic simplification of vocabulary—the use of plain language—can benefit all students, including students with limited English proficiency. Plain language strategies include: reducing wordiness and removing irrelevant material; eliminating unusual or low frequency words; avoiding ambiguous and irregularly spelled words; avoiding proper names; avoiding inconsistent naming and graphic conversions; and marking all questions.
7. Maximum legibility—refers to clear, uncomplicated, and legible text, graphs, tables, and graphics, and response formats.

English Learners

Science teachers who assess English learners will need to insure that these learners have a reasonable way to communicate what they are learning. Language barriers in the testing process need to be modified so that the focus of the assessment is on science learning, not on the mastery of English (Carr, Sexton & Languoff 2007).

A variety of accommodations can be implemented that can make assessments fair for English learners. These accommodations should address the same content standards for all students while, at the same time, offering students different ways of performing that respects their differences and yields accurate results. Accommodations are intended to elicit the most accurate information about what students know and can do without providing an unfair advantage to students who do not receive an accommodation (Carr, Sexton & Languoff 2007).

The table in Figure 9 below describes common testing accommodations that teachers may use in their classrooms with English learners. These accommodations can be used with formative and summative assessments (Carr, Sexton & Languoff 2007).

Figure 9: Assessment Accommodations for English Learners

Test Accommodations	Purpose or Use
Extra Time	Extra time is required to read and understand test

	questions. English learners need to engage in extra thinking to respond to questions in English.
Word Walls, Glossaries, Dictionaries	Word walls created during instruction provide reference during assessment so English learners can communicate understanding easier. Use English and/or bilingual dictionaries when appropriate.
Notes in Primary Language	Student notes from instruction in their primary language helps them to produce answers they know in their primary language.
Models & Rubrics	Provide models of expected work for students who have not experienced the type of assessment before. Preview the rubric that will be used to score student work. Previewing models and rubrics before an assessment helps students understand assessment objectives.
Enhanced Test Directions Checklists	Read directions aloud and rephrase them so that students know what is expected. Simplify test directions as much as possible—one step at a time—allowing students to respond in between steps. Use checklists for directions.
Oral Responses	Test anxiety can make communication in English more difficult. Allow English learners to give oral responses. Prompt students individually and scaffold the conversation to elicit meaningful responses. Provide support for constructed response items with sentence frames for written answers.
Illustrations, Graphic Organizers	Allow students to express ideas with labeled drawings, diagrams or graphic organizers. Ask students to follow up with oral explanations or demonstrations.
Hands-on Activities	Have students perform an activity or experiment and tell what they are doing and thinking. Orally prompt students as needed.
Language Conventions	Focus on student understanding of science content during a science assessment and ignore language conventions. Address language conventions during instruction.
Small Groups	Administer assessments to small groups of English learners using prompts and scaffolds and allowing for oral responses.

References

- Boon, Burke, & Fore 2006 (get from H/SS)
- Broderick, Mehta-Parekh, & Reid 2005 (get from H/SS)
- Carr, J., Sexton, U., & Lagunoff, R. (2007) *Making Science accessible to English Learners*. San Francisco, CA: WestEd.
- Heacox 2002 (get from H/SS)
- Thompson, S.J., Johnston, C.J., & Thurlow, M.L. (2002). Universal design applied to large-scale assessments (Synthesis Report 44). Minneapolis, MN: University of Minnesota, National Center on Educational Outcomes.

- Anstrom, K. (date?). Preparing secondary education teachers to work with ELL: Science. www.ncela.gwu.edu/pubs/resources/ells/science.htm.
- Armbruster, B. (date?). Vocabulary in content area lessons. www.schoolsmovingup.net/cs/wested/view/rs/10080.
- Burhow, B. & Garcia, A. (2006). Ladybugs, tornadoes, and swirling galaxies : English language learners discover their world through inquiry. Stenhouse: 2006.
- Carrasquillo, A.L. & Rodriguez, V. (date ?). Integrating language and science learning in language minority students in the mainstream classroom. Multilingual Matters.
- Chamot, A. (date?). Strategies to accelerate academic learning the English learners. www.calla.ws.
- Dobb, F. (date?). Introducing English learners to the language of science: One discourse pattern at a time. <http://csmc.ucop.edu/downloads/csp/ScientificDiscourse.pdf>.
- Dong, Y.R. (2004). Educating language learners: Getting at the Content. ASCD, December 2004, 62(4).
- Girill, T.R. (date?). How document design helps English learners master science. <http://www.sigdoc.org/newsletter/archives/dec05features.html#how>.
- Hiebert, E. (date?). Critical science vocabulary. www.schoolsmovingup.net/cs/wested/print/htdocs/home.htm.
- Hill, J.D. & Flynn, K.M. (date?) Classroom instruction that works with English learners. ASCD
- Merino, B. & Scarcella, R. (date?). Teaching science to English learners. www.lmri.ucsb.edu.
- NSTA 92006). Reaching the hard to reach science and children. January 2006.
- Ragan, A. (date?). Teaching the academic language of textbooks: A preliminary framework for performing a textual analysis. http://www.coursecrafters.com/ELL-Outlook/2005/nov_dec/index.html.
- Reiss, J. (2008). 102 content strategies for ELL. Pearson: 2008.
- Schiffini, A. (date?). Language, literacy, and content instruction: Strategies for teachers.
- Willoughby, J. (date?). Helping English language learners in the science classroom. www.glencoe.com/sec/teachingtoday.