DOCUMENT RESUME

ED 349 844 FL 020 679

AUTHOR Fathman, Ann K.; And Others
TITLE Teaching Science to English Learners, Grades 4-8. NCBE Program Information Series Guide 11.
INSTITUTION National Clearinghouse for Bilingual Education, Washington, DC.
SPONS AGENCY Office of Bilingual Education and Minority Languages Affairs (ED), Washington, DC.
PUB DATE 92
CONTRACT T289004001
NOTE 32p.
PUB TYPE Guides - Classroom Use - Teaching Guides (For Teacher) (052)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Class Activities; Classroom Techniques; Curriculum Development; *English (Second Language); *Instructional Design; Interdisciplinary Approach; Intermediate Grades; Junior High Schools; Language Proficiency; *Limited English Speaking; *Science Activities; *Science Instruction; Second Language Instruction; Student Evaluation
IDENTIFIERS American Association for Advancement of Science

ABSTRACT

This guide is intended to help teachers plan, design, and implement science activities for students learning English as a Second Language (ESL) in grades 4-8, in mainstream science classes, ESL classes, bilingual education programs, and also to help others serving this population. Steps for designing science experiments that integrate language and science content effectively are presented. The activities included have been used successfully with this group. Principles of learning and teaching proposed by the American Association for the Advancement of Science are enumerated and explained, and specific strategies for integrating language and science are outlined, including teacher collaboration, student collaboration, modifying language for clarity, using material that is meaningful to students, adapting science materials for student language proficiency levels, using language teaching techniques, and varying instructional strategies according to student proficiency. A discussion of the design of science activities for ESL students offers a model procedure in which science concepts are examined through three activity types: teacher demonstration, then group investigation, and finally, individual investigation. Appropriate science concepts and language functions are discussed. Sample activities on heat, animals, and plants using this procedure are outlined in detail. A 24-item bibliography is included. (MSE)

NCBE

11

Teaching Science to English Learners, Grades 4–8

by

[redacted]

Ann K. Fathman

Mary Ellen Quinn

Carolyn Kessler

Acknowledgments

We wish to express our appreciation to Jackie Caruso, an ESL teacher, and Hilaria Bauer, a bilingual teacher in San Antonio, Texas, and Catherine Wachtler, a science teacher in Redwood City, California, for providing insightful comments and ideas on integrating science and language learning.

The National Clearinghouse for Bilingual Education (NCBE) is funded by the U.S. Department of Education's Office of Bilingual Education and Minority Languages Affairs (OBEMLA) and is operated under Contract No. T289004001 by The George Washington University's Center for the Study of Education and National Development, jointly with the Center for Applied Linguistics. The contents of this publication do not necessarily reflect the views or policies of the Department of Education, nor does the mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government. Readers are free to duplicate and use these materials in keeping with accepted publication standards. NCBE requests that proper credit be given in the event of reproduction.

National Clearinghouse for Bilingual Education
1118 22nd Street NW, Washington DC 20037

Director: Joel Gómez
Publications Coordinator: Lorraine Valdez Pierce

Introduction

Evaluating a science investigation on bending light conducted in her eighth-grade English as a second language (ESL) class, Elena wrote,

> I liked the science experiment we made and the 'how-to paper', too. I learned something new and it was fun to worked in groups.

Arturo elaborated on Elena's evaluation in his written follow-up:

> The science help us comprehend the phenomenons of the Nature. for this reason the experiment was very interesting because working in groups helped us practice english. . . .Also I learned new vocabulary words for example: beam, divergent, coin, convergent, inclined surface, measure, path, refraction etc. I like the experiment because I learned the objective of the experiment "the refraction of the light" I would like to make more experiments.

Studying factors that affect the taste of foods, fourth-grader Veronica wrote in her summary, *I realy like doing this. I learned a lot of things today.* In praise of his cooperative learning group, Ernesto added, *We are group two. Science is the best subtec.*

These students have succinctly summarized the value of integrating science and language learning. Each student sees how doing science, especially through collaborative interactions, has an important payoff for learning language. Science activities in an ESL classroom or in a science classroom where students are acquiring English as a second language—either setting can effectively provide conditions for acquisition of both language and science concepts for students learning English as a non-native language at all levels of English language proficiency.

The purpose of this guide is to help teachers plan, design, and implement science activities for students learning English as a second language in Grades 4–8. Steps to designing science experiences that effectively integrate language and science content are presented. The sample activities presented in this guide have been successfully used with English language learners at the upper elementary and middle school levels. The information in this guide should be useful to teachers working with students in science classes, ESL classes, bilingual programs, or other programs that serve students who need special help in developing English language skills.

Integrating Science and Language Learning

Science activities can provide meaning-making experiences about the biophysical environment for English language learners. In order for new knowledge to be acquired—in science and in language—it must be an active, meaning-making process. The science classroom can also provide an excellent atmosphere for developing the kinds of social behaviors students need in order to find solutions to local and global problems. In science, language becomes the tool for communicating meanings and solutions.

For students learning English as a second language, new science concepts can pose difficult problems. Abandoning previously acquired knowledge is a challenging process and may be accomplished only superficially even after formal science teaching. This is particularly relevant for learners who come from diverse cultural backgrounds with world-views that may differ from those reflected in the science classroom (Kessler & Quinn, 1987).

To promote the development of a second language through science, it may be helpful to examine learning and teaching principles that aid in the acquisition of both language and content. The principles of learning and teaching that form the basis for a new core science curriculum are remarkably similar to those widely recognized for promoting second language acquisition. The American Association for the Advancement of Science (AAAS) (1989) has formulated a set of recommendations on scientific literacy (including science, mathematics, and technology) as a conceptual base for reform in science education. Both the learning and teaching principles adapted from the Association's recommendations, as specified in *Science for All Americans,* are listed and explained below in the context of how science and language learning can be integrated (Kessler, Quinn, & Fathman, 1992).

Learning Principles

The five learning principles proposed by the AAAS include the following:

1. Prior knowledge influences learning.
2. Learning moves from the concrete to the abstract.
3. Learning requires practice in new situations.
4. Effective learning requires feedback.
5. Learning is not necessarily an outcome of teaching.

Prior knowledge influences learning.

Learners construct their own meanings by relating new information and concepts to what they already know. Second language learners come to science with world-views shaped by prior knowledge gained from personal and cultural experiences. This prior knowledge helps students who have been exposed to science concepts and methods in their native languages to acquire similar concepts in a second language. The universality of scientific principles, laws, and procedures across cultures can help students as they learn about those same principles in a new language. However, effective science learning frequently requires that learners restructure their understandings, change perceptions, and even discard long-held beliefs. Learning a second language also requires restructuring within the brain, making new connections between words and concepts and discarding old ones, and changing or resetting parameters already in place (Cook, 1989).

Learning moves from the concrete to the abstract.

Concrete experiences—visual, auditory, tactile, and kinesthetic—facilitate understanding of abstract concepts and the acquisition of relevant conceptual structures or schemata. Science investigations can actively involve students in carrying out the processes of science by moving from observing and measuring concrete objects to classifying, hypothesizing, and interpreting results (Rupp, 1992). Graphic organizers, charts, diagrams, visuals, objects, and living things that can be touched and manipulated help in making the connections between words and meanings that are needed in order for understanding to occur.

Learning requires practice in new situations.

In science, if students are to learn to think critically, analyze information, make logical arguments, communicate scientific ideas, and work as part of a team, they need to apply ideas learned in one context to new and realistic situations. Students need opportunities to apply the processes of science so that science comes to be understood, not as a set of facts to be memorized, but as a method for approaching important questions. Language learning requires similar conditions—opportunities for using language in new and authentic settings—if learners are to internalize the new language system and engage in higher order language processing. Learning to negotiate meaning through interaction with others requires exposure to many genuine, real-life communicative situations such as those science can provide.

Effective learning requires feedback.

Feedback is more than just giving correct answers. Feedback means guiding students in analytical thinking processes and providing suggestions for alternative ways of thinking. Feedback must come at a time when students are "tuned in" so that they can reflect, make adjustments, and try again. Feedback plays a critical but complex role in science and second language learning. Error correction for its own sake has little value, but given in an appropriate manner and at a time when the learner is ready, it can trigger the necessary conceptual and language modifications. Interestingly, peer feedback is often more powerful than that given by the teacher.

Learning is not necessarily an outcome of teaching.

Good instruction does not necessarily lead to student understanding. Emphasis on the quality of understanding, rather than the quantity of information presented, is important for successful science and language learning. Selecting only the most important concepts and skills to teach enhances the quality of learning. The quantity of concepts presented needs to be kept at a level that facilitates language acquisition (Krashen, 1987). Overwhelming learners with input that is beyond their level of comprehension can only set up frustrations and block learning.

Teaching Principles

Principles outlined by the AAAS for effective science teaching also relate closely to those for good language teaching. These include the following:

1. Teaching is consistent with the nature of scientific inquiry.
2. Teaching reflects scientific values.
3. Teaching aims to lower learning anxieties.
4. Teaching extends beyond the school.

Teaching is consistent with the nature of scientific inquiry.

Scientific inquiry calls for posing a problem, generating solutions to the problem, testing for solutions by gathering and organizing information, and drawing conclusions about the solution to the problem. Effective science teaching provides concrete experiences in that learners raise questions, make predictions and observations, collect data, and reach conclusions. The collaborative nature of science is demonstrated by frequent group activity. Language teaching is consistent with scientific inquiry. Teachers encourage use of oral and written language and emphasize the crucial role of language in understanding and expressing scientific procedures, findings, and ideas. Problem-solving experiences, guided and supported by the teacher, lead to both science and language learning.

Teaching reflects scientific values.

Effective science teaching engages curiosity, creativity, and a spirit of questioning. Students see science as a process, not as a set of truths. An environment where students come to recognize the beauty of nature through science is also one that facilitates language learning. Similarly, effective language teaching taps learners' natural curiosity and nurtures their creativity.

Teaching aims to lower learning anxieties.

Effective teaching reduces anxieties created by both science and language learning by ensuring that students have successful learning experiences. Rather than creating a competitive environment (that can raise anxieties), collaborative activities in language and science help learners value their own contributions and recognize that others are essential to meeting common goals.

Teaching extends beyond the school.

Teaching takes time, more time than is typically available at school. Designing activities that extend investigations beyond the classroom and into the community can enrich science learning while promoting access to English.

Teaching Strategies for Language and Science

Teachers of science to students acquiring English can help students understand the basic content of science while improving their English skills by using specific teaching strategies that reflect the learning and teaching principles discussed above. To successfully teach science concepts to English learners, teachers need to give simultaneous attention to the language used and the content presented. This can be done by using the following strategies:

- promoting collaboration between teachers and among students;
- modifying language;
- increasing the relevancy of science lessons to students' everyday lives;
- adapting science materials; and
- using language teaching techniques in presenting science concepts.

Teacher Collaboration

To ensure that programs for language minority students are truly integrating the teaching of science and language, there is a need for active collaboration between ESL/bilingual teachers and science teachers. Teachers might observe each others' classes and plan together so that topics or vocabulary covered in the science class can be previewed or supported in the language class.

Teachers of science to English learners can gain valuable ideas from language teachers on strategies that enhance the development of language skills. *Sheltered English* is an approach in which modified or simplified language is used to teach content area concepts to students who are acquiring English. In the science or sheltered English classroom, teaching strategies can include the use of language for purposeful communication, reading and writing that leads students to formulate questions about phenomena of interest to them, building and evaluating theories, collecting data, developing hypotheses, interpreting data, and communicating findings.

Student Collaboration

Another teaching strategy for promoting language and science learning focuses on collaboration between students. Cooperative learning can be an effective classroom management approach for promoting collaborative student activities that integrate science and language learning. The positive atmosphere needed for successful student interaction can be facilitated through small group activities. Grouping should be heterogeneous so that team members who are stronger in English language proficiency can help others with weaker language skills carry out each activity. Second language learners who work together effectively in heterogeneous groups take responsibility for each other's learning and develop a positive attitude toward their new language.

For cooperative learning to work as an effective form of classroom management, a number of elements must be in place:

- team formation through various teambuilding activities;
- positive interdependence among team members;
- social skills for working effectively with group members;
- careful structuring of learning tasks; and
- accountability for carrying out tasks successfully (Olsen & Kagan, 1992).

Encouraging learners to serve as teachers for their peers is one way to create functional and successful learning environments. Because cooperative learning teams are not the same as traditional small groups, the teacher's role in structuring this kind of environment is critical.

Science investigations should be personally relevant, socially meaningful, and academically challenging. The emphasis on collaborative inquiry builds on the view that knowledge and understanding are socially constructed through talk, activity, and interaction on meaningful problems. Students share responsibility for analyzing and participating in activities. This is particularly helpful for second language learners who may have the cognitive ability to do the tasks and construct scientific meanings but may be limited in demonstrating this ability through English.

Modifying Language

To make their language more comprehensible to English language learners, teachers can modify how they talk in a number of ways. Science teachers in sheltered English classrooms are constantly aware that students are developing science concepts while learning English. These teachers use a number of strategies for simplifying their language and providing feedback to students; some examples from a unit on nutrients are given below.

Focus on key words.

Science relies upon the presentation of many key vocabulary items. The introduction of new vocabulary should be limited to fewer than twelve words per lesson. Students' knowledge of scientific terms in their native language or of their Latin origins may be helpful in identifying meanings. Vocabulary can best be introduced using real objects, pictures, and visuals. In a lesson on nutrients, for example, words such as *carbohydrates, starches*, and *proteins* can be introduced by bringing in foods or referring to pictures of foods containing these nutrients. The meaning of a more abstract term such as *calories* can be demonstrated by using a chart that depicts the number of calories contained in various foods (e.g., bread, fruit, meat) or the number of calories burned by doing various activities (e.g., sitting, walking, running). Some students may grasp the meaning of *calorie* only after having participated in an activity such as burning different foods and measuring temperature changes. For the English learner, it is essential for the teacher to re-introduce key words in different contexts and guide students in using these words during scientific investigations.

Use words with personal references.

The meaning of scientific terms can be clarified and personalized through careful choice of vocabulary, as in the following:

> *Your body needs nutrients. You get these nutrients from your food.*

The personal reference to *your body* and *your food* focus on the student and familiar everyday vocabulary and concepts.

Use shorter and less complex sentences.

Scientific language often contains complex sentences in the passive voice. These types of structures can be shortened and expressed in the active voice. For example, the statement

> *Nutrients are needed by living things; therefore, one's daily diet should contain the proper nutrients*

could be simplified to

> *All living things need nutrients. A good diet contains the proper nutrients.*

Repeat or paraphrase whenever possible; pause frequently.

A concept, once presented, should be reintroduced in a number of ways and in various situations. Repeated exposure reinforces key concepts and helps ensure comprehension. The teacher can begin by consciously paraphrasing an idea in different ways using extended pauses between ideas. For example:

> *Food is the source of nutrients. You obtain the nutrients you need from food. Food provides your body with the nutrients it needs. Living things use different foods. But all living things need the same nutrients. Food is always the source of nutrients for living things.*

Some students might be able to grasp an idea after listening to a discussion on it while others need to experience concepts through physical involvement before they are capable of full understanding. Science activities can provide different ways of exploring a concept, just as language can provide diverse ways of expressing an idea.

Intersperse more questions within discourse.

Teachers can ask questions to help students understand, to encourage critical thinking, or to find out what students know about a science concept. Questions can vary in both linguistic difficulty and cognitive complexity. Teachers should be aware of both aspects of the questions they ask, for a question that may be the least cognitively demanding may be quite linguistically complex.

The simplest questions in terms of cognition often involve a *choice*, e.g., "Do horses eat grass or do they eat meat?" Another type of question usually requiring linguistically simple answers is a *factual recall* question such as, "What nutrients supply the energy for your body?" A type of question frequently used in science lessons is the *interpretive* question that can be used to summarize or talk about what has been learned: "Why do you need food? What would happen if an animal did not get food?" Questioning during and after science activities can begin with factual recall and be expanded to explanations of causes or principles involved. Teacher questioning enhances interaction, serves as a model for student questioning, and encourages the development of inquiry skills in the science classroom.

Provide feedback on language through restatement, not overt correction.

When evaluating students' speaking skills, teachers should focus on the accuracy of information they give, not on the correctness of their pronunciation or grammar. Errors are a natural occurrence in the second language acquisition process, and the best way for teachers to encourage students to express themselves is to model correct forms through restatement. The following interaction between teacher and student demonstrates how a teacher can effectively use restatement.

Teacher: "What are some foods that contain protein?"

Student: "Some food are eggs, milks, meats."

Teacher: "Yes, some foods that contain protein are eggs, milk, and meat."

This type of response by the teacher encourages the student and allows the teacher to model the correct forms indirectly.

Making Science Meaningful

Teachers can make science materials more meaningful and increase student motivation by using real objects and visuals and relating these to students' everyday lives. Examples from a unit on weather are described to show how teaching strategies can be used to make science meaningful.

Present new material orally, using real objects and visuals.

Teachers should introduce topics whenever possible by using demonstrations, real objects, pictures, films, and other visual or physical clues to clarify meaning. For example, real thermometers should be available to students when talking about temperature measurement.

Take into consideration the backgrounds and interests of the students in preparing and presenting materials.

Students bring varied and often rich experiences from their cultures. They should be encouraged to share their personal experiences when exploring science topics together. For example, discussions might center on weather differences in their native countries and how weather affects the way people live and dress. Personal experiences increase student interest in a topic, make a new topic relevant to previous experience, and motivate students to explore and learn more about a topic.

Encourage students to talk about what they have done and have them provide feedback to each other.

Communication occurs naturally when students work in groups, and teachers should design oral and written tasks that require students to communicate and share information at every step. Teachers should frequently model questioning and provide special instruction on how to formulate questions and use them appropriately in various contexts. A group investigation in which students examine changes in water vapor is an example of an activity that encourages and requires students to exchange information. Such an activity might proceed as follows:

1. As a group, students make predictions about humidity in the air.
2. Pairs of students work together using thermometers to build hygrometers.
3. Student pairs test humidity in the air in various locations.
4. As a group, students record and share their results.

Science problem-solving activities such as this one provide a common experience on which students can build other experiences, such as questioning, exchanging ideas or results, and arriving at conclusions.

Extend the learning activities beyond the classroom.

Activities that bring adults other than the teacher into the classroom or encourage investigation outside the classroom can greatly benefit students with a limited knowledge of English and the American culture. Almost all science inquiries can be successfully extended beyond the classroom. Activities such as the following could be incorporated into a unit on weather:

- taking a field trip to a weather station;
- following weather reports in the newspaper or on television;
- interviewing a meteorologist;
- measuring precipitation in different locations; and
- observing cloud formations.

All science inquiries should be open-ended to the extent that students are encouraged to continue questioning and investigating outside the classroom.

Adapting Science Materials

In addition to making their oral presentations more comprehensible, teachers of English language learners can also make science texts and written materials more useful to students by adapting them. Kessler & Fathman (1985) suggest developing introductions, supplements, and reviews of written materials that present science materials in a modified format. Adaptations will vary depending on the proficiency level of the students for whom they have been written.

Teachers may find useful some of the strategies for adapting written science materials discussed below. Examples are taken from a chapter in a sixth-grade science text on **Force**.

Identify the most essential facts, vocabulary, and skills.

Teachers should analyze textbook chapters from the point of view of the language learner. Important facts and vocabulary are relatively easy to identify in written materials. In adapting materials, teachers should focus on words in bold print, in headings, and in the chapter summaries found in textbooks. In a chapter on force, for example, the words *force, lever, fulcrum, inclined planes, wheels,* and *pulleys* describe key topics. Teachers can pool material from each unit and prioritize vocabulary items and facts for presentation to students acquiring English.

Provide sociocultural knowledge where students might not share background.

Texts written for native speakers of English may assume previous knowledge about concepts or objects that are unfamiliar to students from another culture. For example, a text may use examples of different kinds of levers to clarify the meaning of *lever*. However, many English learners may have never seen or used the objects mentioned, such as *pruning shears, tweezers,* a *nutcracker*, or a *seesaw*. Teachers should make a special effort to bring in objects or use visuals that provide all students with the background necessary to understand written science materials.

Summarize written material orally first.

An oral preview on a topic using objects and visuals can facilitate reading comprehension on that topic for second language learners at all levels. Oral previews may include teacher-directed summaries, audiotapes of summaries or readings, language master cards of key words, or oral activities (e.g., pair activities or role plays). In preparing students for a reading on force, a teacher might show slides of a child pedaling a bicycle, rowing a boat, or hitting a ball, and get students to talk about what kinds of forces are involved.

Teach skills for previewing, questioning, and reviewing written material.

Students acquiring English should be taught study skills for dealing with written science materials. In any given class, these students will exhibit a wide range of previous educational experiences. Students may need to be guided in how to use science textbook aids such as glossaries, captions, titles, headings, graphs, and charts. Most science texts for the upper elementary and middle school are full of pictures, illustrations, and examples that can be used to help language learners comprehend what they are reading in English. Teachers can encourage students to use study techniques such as the Survey, Question, Read, Recite and Review (SQ3R) approach, that suggests students first scan the material in a textbook chapter for key concepts and vocabulary, develop questions regarding the reading passage, read the passage, recite the key ideas, and review the chapter to ensure nothing essential has been missed.

Using Language Teaching Techniques

Teachers need to continually support language learning while teaching science content. This can be done by incorporating language teaching techniques into science lessons. Science and language are so closely linked that teachers need not contrive artificial situations to promote language learning. Through science problem-solving activities, students are motivated to communicate, and language acquisition occurs naturally. Teachers should be aware, however, of specific techniques for integrating the teaching of language and science.

Science teachers may want to become familiar with techniques associated with various second language teaching methodologies and approaches. For example, Total Physical Response methods (Asher, 1977) emphasize the importance of physical involvement in language learning. In science activities, students can be encouraged to describe their actions orally while they demonstrate how to do something. Hands-on science inquiries provide a perfect setting for talking while being physically involved. The Natural Approach (Krashen & Terrell, 1987) suggests that students be allowed to progress naturally through various stages of language acquisition. Teachers are encouraged not to force students to speak but to allow a silent period when working with beginning students or introducing new topics. Teacher presentations and science manipulative activities provide a means for students to listen or participate without being forced to speak or answer questions. A familiarity with various methodologies (see Richard-Amato, 1988) will allow teachers of science to use techniques that have been successfully used in teaching English to second language learners.

Varying Instructional Strategies

Teachers should vary instructional strategies according to the proficiency levels of their students (Richard-Amato & Snow, 1992). Beginning students are more dependent on gestures, visuals, and objects, and may comprehend only words or phrases. Intermediate students may express themselves with difficulty and often be misunderstood. These students can benefit from simplified language input, both oral and written, and can be expected to write with numerous errors, using simple grammar and limited vocabulary. More advanced students can comprehend most of what is said in the mainstream classroom but may make occasional errors and have a limited vocabulary in speaking and writing. They continue to benefit from lessons that incorporate contextual support and redundancy to clarify science concepts. Science teachers, whether in mainstream or sheltered classes, should be aware of each student's language proficiency level and adapt their teaching strategies accordingly.

Assessing Student Progress

In addition to being knowledgeable about instructional strategies, teachers should also become familiar with various assessment procedures. The progress of each student should be continually monitored in language and in science. Assessment can be conducted in numerous ways, e.g., through oral questioning and reviewing, written assignments and tests, and portfolios. Continual assessment of conceptual understanding as well as of oral and literacy skills allows a teacher to know where individual student strengths and weaknesses lie. Alternative (non-standardized) methods of assessment should be used, since a student may be strong in conceptual understanding but weak in literacy and test-taking skills needed for succeeding on standardized tests. Information generated by alternative assessments can be invaluable in determining which students need individual help, in planning assignments, and in developing and evaluating the science curriculum. For a description and examples of how to develop alternative assessment procedures for language minority students, see Pierce & O'Malley (1992). For information on alternative assessment in science, see Educational Testing Service (1987) and Hein (1990).

Teachers who collaborate with each other, modify their language, adapt science materials, and encourage student involvement and cooperation in the classroom provide a setting that allows students to progress in the understanding of science concepts while developing English listening, speaking, reading, and writing skills.

Designing Science Activities for English Language Learners

A Model Unit for Science and Language Learning

In teaching science to English learners, the main concerns of the teacher are to make the science material understandable and meaningful, to motivate and involve the students, and to enhance communication. One approach to achieving these goals is to explore each science concept in different ways. This provides students with multiple occasions for listening to and using language structures and vocabulary related to a particular science concept. Fathman & Quinn (1989) have outlined a model for teaching science to students acquiring English in which science concepts are examined through three types of activities: a teacher demonstration, a group investigation, and an independent investigation.

By investigating each science concept through these three types of activities, students progress from a carefully guided presentation to an organized group inquiry to open-ended individual study. The sequencing of activities from teacher-directed to group-centered and student-initiated activities allows students to progress naturally through stages of language learning — from observing to solving, listening to speaking, interacting to initiating.

The focus in all three types of activities should be on *inquiry*. Even during a demonstration activity, the teacher should *guide* students into questioning and discovering relevant facts and concepts. Teachers should encourage critical thinking that facilitates comprehension of oral and written material and develops students' abilities to analyze that material. Activities should be open-ended so students can initiate and discover different ways of solving problems. Whether observing a demonstration, participating in a group, or working individually, students should develop an understanding of how to investigate through scientific observation and the collection and interpretation of data.

Before doing a *demonstration*, the teacher should find out what students already know about the topic to be presented. In this way, students' prior knowledge is activated. A teacher demonstration can serve a number of important functions such as: introducing a concept, creating interest in a topic, stimulating thinking so that students are ready to continue investigating on their own, showing students how to do something, and raising questions or presenting problems to solve. A demonstration can give students the opportunity to listen and observe before having to produce any language. The focus can be on the development of comprehension skills or on the learning of new vocabulary or concepts. In a demonstration, students watch and listen as the teacher speaks. A demonstration can be extended by having students repeat or modify what was said or done or take part in the discussion accompanying the demonstration. An initial oral and visual preview to a concept can greatly benefit a student's understanding of that topic.

After the teacher demonstration, a *group investigation* enhances comprehension and production skills through student interaction and allows for further exploration of science concepts. Cooperative work in science activities provides an ideal environment in which to learn a new language. Language is acquired naturally as students listen to others and express themselves while working in a group.

Heterogeneous grouping of students at different proficiency levels is important for providing models of good language use. More advanced students may need little guidance in following directions or carrying out an inquiry, and they can provide help for students who have less English proficiency. Roles taken by students within a group can be varied according to each student's proficiency level. For example, a student who is able to read and write English can record the results of an investigation while a student who writes little English might record numbers on a chart or draw pictures illustrating the group's findings. Student participation and interaction should be encouraged through the questioning, observing, recording, and interpreting of data obtained by each group.

As a follow-up to the group activity, an *independent investigation* allows each student to examine a science concept on his or her own. Independent activities can also be carried out by pairs of students who may not yet be ready to work individually. An independent activity allows students to explore questions related to a science concept already familiar to them and extend their inquiries outside the classroom. Students at almost all levels of English proficiency can carry out individual inquiries, but they will differ in their ability to describe their observations and express solutions.

Science Focus: Sample Science Concepts

The selection of appropriate science concepts for English learners will depend on the school curriculum, program objectives, and the type of class and students involved. Usually a curriculum or science framework will determine the concepts to be addressed in an upper elementary or middle school classroom. Science textbooks and materials are the obvious source for selecting concepts; units or chapters focusing on concepts and subtopics can be used as the basis for demonstration, group, and individual activities. Teachers can focus on the science concepts they want to teach and the language their students will need in order to communicate about these concepts.

In addition to science textbooks and materials, many other popular sources provide ideas for problem-solving activities in science. Some useful resources include:

The Science Teacher (National Science Teachers Association);
National Geographic World (National Geographic Society);
Mr. Wizard's 400 Experiments in Science (Herbert, 1968);
Mr. Wizard's Supermarket Science (Herbert, 1980);
Science on a Shoestring (Strongin, 1976);
Science Weekly (Science Weekly);
Wonderscience (Nichols & Nichols, 1990); and
Project AIMS Materials (AIMS Education Foundation).

The sample concepts and activities that follow are brief examples of how to present science concepts using a teacher demonstration followed by group and independent activities.

1. **Concept: Electrical energy causes motion.**

Teacher Demonstration	*Group Investigation*	*Individual Investigation*
Use an inflated balloon to pick up small pieces of paper.	Use an inflated balloon to cause another balloon to move.	Use an inflated balloon to test what objects it will pick up.

2. **Concept: Rapid motion causes the temperature of objects to rise.**

Teacher Demonstration	*Group Investigation*	*Individual Investigation*
Rub a wooden block over sandpaper to show how the temperature of the block goes up.	Bend a paper clip rapidly back and forth and use cheeks to test for temperature change.	Find other objects (e.g., saw, chisel, file) outside of class that change temperature after rapid motion and test them for temperature change.

3. **Concept: Animals move in different ways; some animals move by stretching.**

Teacher Demonstration	*Group Investigation*	*Individual Investigation*
Use earthworms to show how they move by stretching because they have no legs.	Observe earthworm activity when these are placed in a carton of soil.	Find examples of other animals without legs outside of class or in pictures. Name and classify them according to how they move.

4. **Concept: Rapidly moving air causes some objects to rise.**

Teacher Demonstration	*Group Investigation*	*Individual Investigation*
Hold a long piece of paper to the bottom lip and blow hard across the top of the paper to show how it moves up.	Blow hard across the top of a balloon and then try to explain why it rises and what makes airplanes rise into the air.	Use a fan to see what objects you can lift up into the air.

Language Focus: Sample Language Functions

In designing science activities for English learners, a teacher may want to focus on one or two language functions that are particularly appropriate for each activity. Language functions are specific uses of language for accomplishing certain purposes. An analysis of the kinds of functions needed in science activities is an essential first step in choosing a language focus for science lessons. The grammar focus can be determined by the structures necessary to express each language function. By focusing on functions used in science lessons, teachers provide students with information that has immediate practical value for understanding and communicating both in and out of the classroom.

Some language functions that are frequently used in the science classroom are listed below.

directing	refusing	describing	disagreeing	praising
requesting	accepting	expressing opinions	advising	cautioning
questioning	defining	agreeing	suggesting	encouraging

Teachers can focus on language functions through oral ("What to Discuss") and written ("What to Record") exercises completed by students during and after an investigation (Fathman & Quinn, 1989). These exercises should vary in difficulty so that students at different proficiency levels can participate in activities, record their observations, and comment on their findings.

Language functions can be incorporated throughout science activities. For example, *directing* (giving and following directions) may be emphasized in an activity where the teacher first gives directions on how to build a rocket. This can be followed by an activity in which students work in groups to direct each other in building their own paper rockets.

Steps for Designing a Science Unit

The steps outlined below suggest how a teacher can develop activities on a science concept or theme.

1. Select a topic, e.g., *heat, light, animals.*
2. Choose a science concept, e.g., *light bends, water condenses.*
3. Identify the language functions necessary for science activities, e.g., *requesting, directing, informing.*
4. Design a teacher demonstration related to the concept.
5. Design one or more student group investigations to explore the concept.
6. Design individual or paired student investigations to explore the concept.
7. Plan oral exercises for developing listening and speaking skills.
8. Plan written exercises for developing literacy skills.

Sample Science Activities

The following activities are based on *Science for Language Learners* (Fathman & Quinn, 1989). Examples from units on **Heat, Animals,** and **Plants** show how science concepts and language functions can serve as the basis for the three types of activities in each unit (teacher demonstration, group investigation, and individual investigations). These examples present basic concepts and suggest activities that can lead to further study and investigation of each topic.

HEAT

Science Concept:	Heat is a form of energy that changes the size and shape of things.
Language Functions:	Describing and defining

Teacher Demonstration

The teacher pops some corn to show that heat causes a change in size and shape (by changing liquid to vapor/gas inside the kernel).

What to Use

air popcorn popper, popcorn, metric ruler

What to Do

1. Ask students to notice the relatively small size of the corn kernels.
2. Ask students to measure the depth of the corn in the pan.
3. Have them predict what changes will occur in the popcorn; write these on the board.
4. Pour corn into the popper and turn it on.
5. Have students measure the depth of the popped corn and observe the shape of grains.

Words to Study

The teacher or students can identify key words used during the demonstration, such as *heat, shape, kernel, grain,* and *pop.*

What to Discuss

1. Students should describe the kernels of corn before and after heating.
2. Have students describe and follow each step of the teacher's demonstration.
3. Ask students to think of other foods that change size and shape when heated, and discuss why these changes occur.
4. Discuss questions such as: When do the kernels of corn change? What kind of energy is changed to heat energy?

What to Record

1. Ask students to draw a picture of a kernel of corn before and after heating. They should write words that describe each picture.
2. Have students measure the kernels before and after heating. They should also record the measurements on a chart and describe changes in their color and shape (see Figure 1 below).

Figure 1

Record Chart: Size, Color, Shape of Kernels

SIZE BEFORE HEATING	SIZE AFTER HEATING	COLOR/SHAPE AFTER HEATING
1. ________ mm	________ mm	
2. ________ mm	________ mm	
3. ________ mm	________ mm	
4. ________ mm	________ mm	

3. Write a description of what steps the teacher took to pop the corn.
4. Describe in writing the changes in shape, color, and form of the corn kernels.

Group Investigation

Students predict how long it will take birthday candles to melt (as heat changes a solid to a liquid) and test the predictions.

What to Use

two birthday candles, two pieces of foil paper, a clock or watch with a second hand, matches

What to Do

1. Predict how long it will take for a candle to change to a puddle of wax.
2. Fasten a candle to foil paper, light it, and note how long it takes for it to burn out.
3. Repeat Steps 1 and 2 with another candle of the same size in a different place in the room.
4. Compare the results with the predictions.

Words to Study

The teacher or students can make a list of words that might be used to talk about the burning process such as: *light*, *flame*, and *melt*.

What to Discuss

1. Describe to others how the candle changed as it burned.
2. Ask classmates to give definitions of words such as: *size*, *shape*, *solid*, and *liquid*.
3. Discuss questions such as: Do candles always take the same number of minutes to burn? If there is a difference between the time it takes two candles to burn, how can you explain this difference? Why does the candle change from a solid to a liquid?

What to Record

1. Make a chart showing the time predicted for the candle to burn and the difference between the time predicted and the actual time observed, including: the time the candle started burning; the time the candle went out; and the time the candle actually burned. Repeat for candle two.
2. Define important vocabulary by drawing pictures or writing definitions.
3. Describe how a candle turns into a puddle of wax.
4. Write and answer questions about observations and predictions.

Individual Investigation

Use the heat of the room and the heat of your hands to change the size of an ice cube (as heat changes a solid to a liquid).

What to Use

plastic cup, plastic bag, two ice cubes, newspaper, ruler, paper towels

What to Do

1. Cover a desk with newspaper.
2. Measure each ice cube.
3. Put one cube in a cup and one in a bag. Repeatedly squeeze the plastic bag with the ice cube in it.
4. Predict what changes will occur.
5. After five minutes measure both ice cubes and compare sizes.
6. Repeat Steps 1–5.

What to Study

1. Compare measurements of each ice cube and try to explain any difference in sizes.
2. Think of other things a person could do to make ice cubes melt.
3. Think of other cold or frozen things that melt and what to do to make them melt faster.
4. Ask and answer questions about observations.

What to Record

1. Record the size of the ice cubes in centimeters (see Figure 2).
2. List five ways to melt ice.
3. Answer questions such as: When does ice melt? What kind of energy is involved in the changes you observed?

Figure 2

Record Chart: Size of Ice Cubes

TIME	SIZE OF CUBE IN HAND	SIZE OF CUBE IN CUP
START	________ cm	________ cm
5 minutes	________ cm	________ cm
10 minutes	________ cm	________ cm
15 minutes	________ cm	________ cm

ANIMALS

Science Concept:	Animals are living things that move by means of their own power.
Language Functions:	Suggesting and expressing opinions

Teacher Demonstration

The teacher shows how some animals make tracks when they move.

What to Use

newspapers, clay, flour or sand

What to Do

The teacher should use newspapers, clay, and flour or sand to show students how tracks are made.

1. Cover a large area of the floor with newspapers. Sprinkle flour or sand on the papers.
2. Have students predict what will happen when they walk across the dusted newspapers.
3. Ask a student to walk across the floured/sanded papers. Ask another student to do the same.
4. Have students examine their tracks. Ask questions that lead students to conclude that tracks can be made only by moving things.
5. Call attention to the different size tracks and that they cross one another.
6. Redust the floor. Ask two students to walk up to one another and then walk away. While they do this, all other students should have their eyes closed.
7. Ask the other students to examine the tracks and determine what happened.

Ask students to look for animal tracks on their way home from school. Give them pieces of clay and ask them to make the paw print of a dog or cat, either by pressing the clay to the animal's paw or into a print that has hardened on the ground. They can also sketch the prints they see. If possible, they can bring the prints and/or sketches to school the next day.

Words to Study

The teacher or students can identify new words used in the demonstration, such as *track, print,* and *movement.*

What to Discuss

1. Make suggestions to classmates on how to find tracks outside the classroom.
2. Name animals that make tracks.
3. Describe different track patterns.

What to Record

1. Draw a set of tracks that tell a story.
2. Write the names of animals that make tracks and the best place to find the tracks.
3. Write suggestions for where and when a person might find animal tracks.

Group Investigation

Students draw animal footprints and use sets of prints to create animal track stories.

What to Use

books, magazines, plain paper, pencils, ink pad

What to Do

1. Use an ink pad to obtain a print from an animal.
2. Draw the print of the animal using the ink pad print.
3. Compare the shape of the print to those of others in the group.
4. Find pictures of various animals in books and magazines.
5. Observe animal behavior in a film, on television, or in the neighborhood.
6. Make track stories by drawing a series of animal prints to show the behavior of animals. For example, show two different animals meeting and going away from each other.

Words to Study

The teacher or students can define new words for this unit, such as *approach, back off, run away, walk away, footprints, attack, fight, meet,* and *sequence.*

What to Discuss

1. Students show their track stories to the others in their group and ask them to guess where the animals were and what they were doing when they made the tracks.
2. Discuss questions such as: How can we tell what tracks belong to which animals? Why are tracks different?

What to Record

1. Keep a record of the prints and names of all the animals we can identify by their prints.
2. Draw a track story with prints. Then write the story in words.
3. Name four things a person can learn from examining a track sequence.

Independent Investigation

The student makes an animal footprint stamp and uses it to create a track 'story' for others to interpret.

What to Use

medium-sized potato, knife or other cutting instrument,* pencil, ink pad, white paper

What to Do

1. Select an animal footprint to use.
2. Prepare a carrot or potato so that it has a flat surface on which to draw.
3. Use a pencil to draw a footprint of an animal on the flat surface.

---

*Teachers are advised to use discretion in allowing students to use a knife. Whereas the authors have successfully used this activity with students in Grades 4–8, they suggest teachers closely monitor students working with sharp instruments.

4. With a knife, carve around the drawing so that the print stands out.
5. Use the footprint stamp and the ink pad to create a track story.
6. Make another stamp and draw a track story about two animals.

What to Study

1. Think of different ways to suggest how a person can make a cat's paw print.
2. Answer questions such as: What did your tracks tell about the animal that made them? Why would tracks be close together?

What to Record

1. Describe the animals whose tracks were recorded.
2. Describe the track pictures in words.
3. Ask other students to interpret the track stories and write down what they say.

PLANTS

Science Concept: As they grow, plants change light energy into chemical energy.

Language Functions: Agreeing and disagreeing

Teacher Demonstration

The teacher shows the different parts of a seed and how to prepare it for germination.

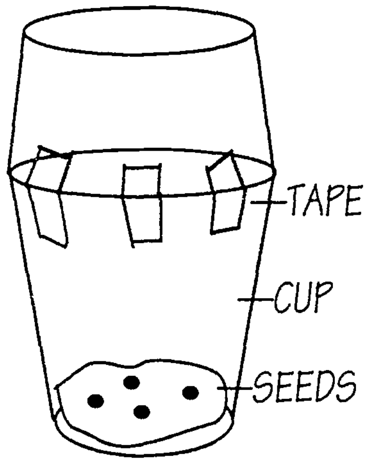
What to Use

a cup of dried kidney and lima beans (soaked overnight before class), two clear plastic cups, paper towels, jar of water, newspapers to cover student desks

What to Do

1. Give each student six or eight kidney and lima beans.
2. Show students how to remove the bean coating with a toothpick.
3. Explain about and show them the three parts of each bean: embryo, food supply, and covering.
4. Ask students to pull their own seeds apart and examine them.
5. Place three or four beans in a crumpled paper towel that has been soaked in water, and place this in one of the plastic cups.
6. Cover the cup with the beans in it with the empty cup. Fasten the two cups together with tape, and place it in a sunny spot (see Figure 3).
7. Ask students to predict what will happen and how long it will take.
8. Ask students to watch the seeds germinate over the next few days.

Figure 3
Germination Cup



Words to Study

The teacher and/or students can make a list of words to study, such as: *bean, seed, embryo, protective covering, encase, curved, supply, germinate,* and *crumble.*

What to Discuss

1. Students should give each other step-by-step directions on how to prepare seeds for germination.
2. Discuss such questions as: Do all seeds have the same parts? Are all seeds the same size or color? Why do the seeds have to be soaked before they can be pulled apart? Why do seeds have a food supply? What are the parts of a seed? Which part is the largest? Agree or disagree with one another's answers.

What to Record

1. Students should draw a picture of a seed and label its parts.
2. Write step-by-step directions for preparing seeds to germinate.
3. Write answers to the discussion questions.

Group Investigation

Students prepare a germination system and observe seeds germinating.

What to Use

newspapers, two clear plastic cups, scotch tape, paper towels, jar of water, ruler, soaked seeds (e.g., lima beans, kidney beans, dried corn kernels, dried peas)

What to Do

1. Examine the germination system that the teacher made.
2. Prepare germination systems the way the teacher has, but put in two of each type of seed.
3. Each group tapes its group number on its system and places it in the sun. Each group should keep its system damp and observe it for several days.

What to Discuss

1. Students should explain why they did the following things: used clear cups, soaked the towels, taped the cups together, and placed the cups in the sun.
2. Answer questions such as: How do seeds get food as they germinate? How do they change as they germinate? How long does it take a seed to germinate? Do they all germinate at the same time?

What to Record

1. Record the type of seeds and the date they were prepared. Indicate the date(s) they germinated. Write the height of each plant every day for at least a week after the plants germinate. To do this, the students can make a chart with four columns (see Figure 4). In the first column, they can write the date they measured the plants. In the third column, they can write the height of each plant, and in the fourth column, they can write a description of each plant.
2. Describe how to make a germination system.

Figure 4

Record Chart: Growth of Two Plants

Date the seeds were prepared: ____________

Type of seed: Plant 1 ________ Plant 2 ________

Date the seeds germinated: Plant 1 ________ Plant 2 ________

Date	Plant	Height	Description
	Plant 1		
	Plant 2		
	Plant 1		
	Plant 2		
	Plant 1		
	Plant 2		
	Plant 1		
	Plant 2		
	Plant 1		
	Plant 2		

Independent Investigation

The student plants seeds and observes plant growth.

What to Use

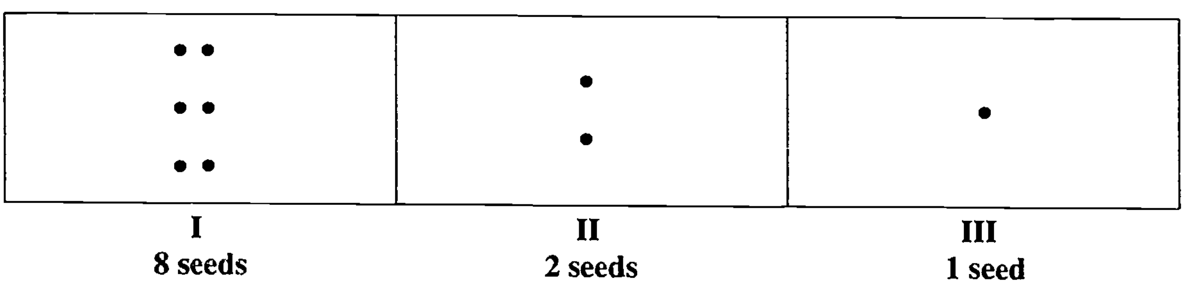
a shoe box lined with plastic or three foil pans, pieces of cardboard, paper and an old pencil, metric ruler, scissors, about twelve corn seeds that have been soaked in water, planting soil, spoon, newspapers, masking tape, a jar of water, paper towels or rags to clean up

What to Do

1. Fill the lined box or foil pans about two-thirds full of soil.
2. If using a lined box, put pieces of cardboard in the box through the soil so that the box of soil is divided into three equal parts (see Figure 5).
3. Use the pencil to make holes in the soil for the seeds. Make all the holes the same depth.
4. Plant eight evenly spaced seeds in the first section of the box.
5. Plant two evenly spaced seeds in the second section and only one seed in the last section of the box.
6. Cover the planted seeds with soil. Water the entire box lightly. Place it in the sun, and observe the plants as they grow.

Figure 5

Planter Box



What to Study

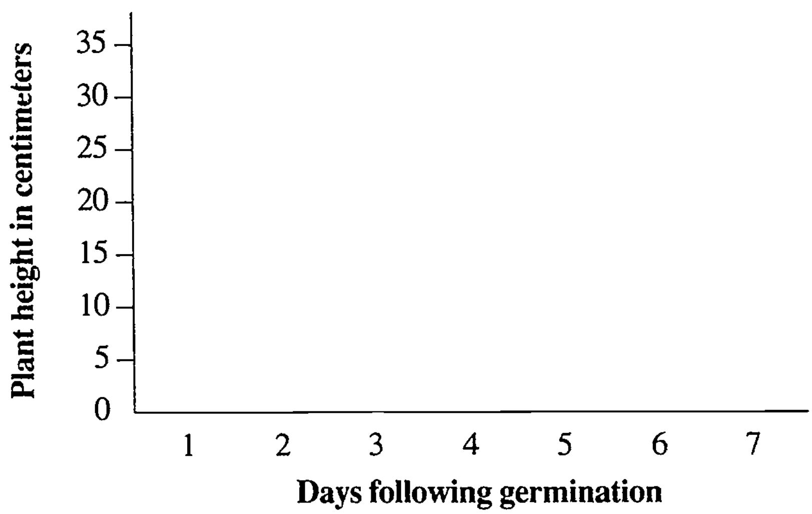
1. Using packages of garden seeds, read each package to determine how far apart different kinds of seeds should be planted.
2. Find which seeds should be placed farthest apart.
3. Try to determine which seeds grow best and why.
4. Try to determine the spacing that is best for corn seeds.

What to Record

1. Make a chart showing the date, height, and a picture of the plants for each section of the plant growing box.
2. Make three graphs to show the average height of plants in each section of the box (Sections I, II, and II) for one week after they germinate (see Figure 6).
3. Study plants near home. Write their names, a description of each one, and how far apart they grow.

Figure 6

Average height of plants, Box Section I (8 seeds)



Conclusion

English language learners bring language and cultural differences to the science classroom. Integrating the teaching of science with language learning through collaborative interaction can result in the active negotiation of meaning through which these students come to learn scientific inquiry processes, English vocabulary and structures, and social interaction skills.

Principles for effective science teaching relate closely to those that promote language learning. These principles call for providing concrete experiences in which learners raise questions, make predictions and observations, collect data, and reach conclusions. They also call for classrooms where students come to see science as a process of inquiry, where anxieties are lowered and students actively collaborate with one another, and where learning extends beyond the classroom.

Principles that promote both language learning and the acquisition of science concepts require relating new knowledge to prior knowledge, moving from the concrete to the abstract, applying concepts in various settings, providing feedback, and making instruction meaningful (not overwhelming) to the learners. One approach to accomplishing this is to explore each science concept in different ways. A model has been presented in which science concepts are examined through three types of activities: a teacher demonstration, a group investigation, and independent student activities.

Teachers of learners of English have the opportunity to help their students progress in understanding science concepts while developing English listening, speaking, reading, and writing skills by applying specific teaching strategies that incorporate language functions and structures into science activities. These teaching strategies include promoting collaboration between teachers and among students, modifying teacher talk, making science relevant to students' everyday lives, adapting existing science materials and textbooks, and using language teaching techniques in presenting science concepts. By applying these strategies, teachers can give English learners the preparation they need for succeeding in the English language science classroom and ultimately in the larger school context.

References

AIMS Education Foundation. (no date). *AIMS educational materials, Grades K-6, 7-9*. Fresno, CA: Author.

American Association for the Advancement of Science (AAAS). (1989). *Science for all Americans*. Washington, DC: Author.

Asher, J. (1977). *Learning another language through actions*. Los Gatos, CA: Sky Oaks Productions.

Cook, V. (1989). Universal grammar theory and the classroom. *System, 17*(2), 169-182.

Educational Testing Service. (1987). *Learning by doing: A manual for teaching and assessing higher-order thinking in science and mathematics*. Princeton, NJ: Author.

Fathman, A.K., & Quinn, M.E. (1989). *Science for language learners*. Englewood Cliffs, NJ: Prentice Hall Regents.

Hein, G. (Ed.). (1990). *The assessment of hands-on elementary science programs*. Grand Forks, ND: University of North Dakota.

Herbert, D. (1968). *Mr. Wizard's 400 experiments in science*. North Bergen, NJ: Booklab.

Herbert, D. (1980). *Mr. Wizard's supermarket science*. North Bergen, NJ: Booklab.

Kessler, C., & Fathman, A.K. (1985). *ESL activities for Heath science, Books 1-6*. Lexington, MA: D.C. Heath.

Kessler, C., & Quinn, M.E. (1987). ESL and science learning. In J. Crandall (Ed.), *ESL through content-area instruction*. Englewood Cliffs, NJ: Prentice Hall Regents.

Kessler, C., Quinn, M.E., & Fathman, A.K. (1992). Science and cooperative learning for LEP students. In C. Kessler (Ed.), *Cooperative language learning*. Englewood Cliffs, NJ: Prentice Hall Regents.

Krashen, S.D. (1987). *Principles and practice in second language acquisition*. Englewood Cliffs, NJ: Prentice Hall Regents.

Krashen, S.D., & Terrell, T. (1987). *The natural approach: Language acquisition in the classroom*. Oxford: Pergamon Press.

National Geographic World. Washington, DC: National Geographic Society.

Nichols, W., & Nichols, K. (1990). *Wonderscience: A developmentally appropriate guide to hands-on science for young children*. Palo Alto, CA: Learning Expo.

Olsen, R., & Kagan, S. (1992). About cooperative learning. In C. Kessler (Ed.), *Cooperative language learning*. Englewood Cliffs, NJ: Prentice Hall Regents.

Pierce, L.V., & O'Malley, J.M. (1992). *Performance and portfolio assessment for language minority students*. Washington, DC: National Clearinghouse for Bilingual Education.

Richard-Amato, P.A. (1988). *Making it happen: Interaction in the second language classroom.* White Plains, NY: Longman.

Richard-Amato, P.A., & Snow, M.A. (Eds.). (1992). *The multicultural classroom: Readings for content-area teachers.* White Plains, NY: Longman.

Rupp, J.H. (1992). Discovery science and language development. In P.A. Richard-Amato & M.A. Snow (Eds.), *The multicultural classroom: Readings for content-area teachers.* White Plains, NY: Longman.

Science Weekly. Silver Spring, MD: Science Weekly Publications.

Strongin, H. (1976). *Science on a shoestring*. Menlo Park, CA: Addison Wesley.

The Science Teacher. Washington, DC: National Science Teachers Association.

☆ US GOVERNMENT PRINTING OFFICE 1992 - 328-426 - 814/70038

About the Authors

Ann K. Fathman is Director of the ESL and TESL Certificate Programs at the College of Notre Dame in Belmont, California. She has taught both science and ESL at elementary and secondary levels. Her publications include *The Second Language Oral Test of English (SLOTE)*, *Science for Language Learners* (with Mary Ellen Quinn), and numerous articles on second language acquisition.

Mary Ellen Quinn is Professor of Mathematics at Our Lady of the Lake University in San Antonio, Texas. She has taught science and mathematics at the elementary, secondary, and college levels. She is co-author of *Science for Language Learners* and "Science and Cooperative Learning" in *Cooperative Language Learning*.

Carolyn Kessler is Professor of English as a Second Language/Applied Linguistics at the University of Texas at San Antonio. She has published widely in journals and texts dealing with bilingualism, second language learning/teaching, and literacy for ESL learners. She recently co-authored *Literacy con Cariño: A Story of Migrant Children's Success* and edited *Cooperative Language Learning: A Teacher's Resource Book*.

ED/OBEMLA92-3

The George Washington University
WASHINGTON DC

Center for Applied Linguistics