Education reform in general, and the No Child Left Behind Act in particular, require that all students achieve high academic standards in core subject areas. Teachers working with students from diverse languages and cultures face the challenge of making academic content and process accessible and meaningful for their students. Despite efforts to ensure that all students receive equivalent content area instruction and fair assessment, opportunities to learn science may be limited for English-language learners (ELLs). With ELLs, teachers are under pressure to promote English language and literacy development as well as academic achievement in the content areas (August & Hakuta, 1997; Garcia, 1999). This may require subject-specific instructional strategies that go beyond the general preparation in English as a Second Language (ESL), English to Speakers of Other Languages (ESOL), or bilingual education that many teachers receive.

In order not to fall behind their English-speaking peers in academic content areas, ELLs need to develop English language and literacy skills in the context of content area instruction. Ideally, content area instruction should provide a meaningful context for English language and literacy development while also improving English skills, providing the means for understanding academic content (Amaral, Garrison, & Klentschy, 2002; Buxton, 1998; Casteel & Isom, 1994; Lee & Fradd, 1998; Stoddart, Pinal, Latzke, & Canaday, 2002). In reality, however, ELLs frequently confront the demands of academic learning through a yet-unmastered language without the instructional support they need. For their part, teachers often lack the knowledge and the institutional support to address the ELLs' educational needs. Thus, a vision of reform to support the academic achievement of ELLs requires integrating knowledge of academic disciplines with knowledge of English language and literacy development. The need for such integration is especially urgent, given the climate of standards-based instruction, high-stakes assessment, and accountability facing today's schools.

Two issues are addressed in this paper. First, literacy development and English language proficiency with ELLs are described. Then, research-based approaches for effective
instruction and assessment with ELLs in academic content areas are discussed. Content examples are drawn primarily from science, but the general features of the discussion are applicable across subjects.

**Literacy Development and English Language Proficiency**

Literacy development involves abilities well beyond being able to speak, listen, read, and write. Literacy involves learning to think and reason, and to view and visually represent pictorial and graphical as well as textual representations of ideas and information. Language functions (e.g., describing, hypothesizing, explaining, predicting, and reflecting) develop simultaneously with science inquiry and process skills (e.g., observing, describing, explaining, predicting, estimating, representing, and inferring). In this sense, science inquiry promotes thinking and reasoning that involves both literacy and science learning (Amaral et al., 2002; Casteel & Isom, 1994; Lee & Fradd, 1998).

Literacy development occurs along a continuum from preliterate, with little or no exposure to text, to the age- and grade-appropriate development necessary for academic achievement. Preliterate students require a great deal of support in academic learning. The study of science enables them to associate real-world objects and events with symbolic representations. Students progress from describing “here and now” events, to reporting “what happens” for those who are not present at the events, and then to hypothesizing about “what will happen.” Through this process, students move from simple and concrete to more complex and abstract ways of thinking.

In addition to general literacy, students need to acquire English language proficiency to effectively participate in mainstream classrooms. English language proficiency involves knowledge and effective use of the conventions of literacy, such as vocabulary, syntax, spelling, and punctuation, in social and academic contexts. In content areas, proficiency includes knowledge of various sub-registers representing specific disciplines (Chamot & O’Malley, 1994). Proficiency also requires the ability to employ non-technical terms in ways that have unique meanings within a given academic discipline, for example, matter, force, energy, and space in science. Furthermore, students learn science through thinking and reasoning as members of a science learning community.
While bilingual education has fallen out of favor in an increasing number of states that adopt English-only policies, there is ample research indicating that developing literacy and proficiency in two or more languages promotes cognitive flexibility and capabilities (Cummings, 1984, 1986). In learning science, students may start by observing, imitating, and interacting with others and gradually learn to perform independently. Through this process, students communicate about science in other languages as well as in English. In addition to promoting academic achievement, the use of students’ home languages enhances their cultural and linguistic identities (Garcia, 1999; Moll, Diaz, Estrada, & Lopes, 1992).

**Effective Instruction and Assessment with ELLs**

Content area instruction for ELLs is often treated as secondary to language instruction. Many teachers, especially at the elementary level, are not adequately prepared in content areas such as science or mathematics, or in subject-specific teaching strategies. Additionally, they are not sufficiently prepared to meet the learning needs of ELLs (National Center for Education Statistics, 1999). Furthermore, many teachers assume that ELLs must acquire English before engaging in content area learning, are unaware of linguistic influences on student learning, do not consider “teaching for diversity” as their responsibility, or purposefully overlook linguistic differences and accept inequities as a given condition (Cochran-Smith, 1995). Such beliefs and practices on the part of teachers almost inevitably lead ELLs to fall behind their English-speaking peers (August & Hakuta, 1997; Garcia, 1999).

**Effective Instruction**

**Academic learning**  Hands-on, inquiry-based science instruction provides opportunities for all students to develop scientific understanding and to engage in inquiry practices (Lee & Fradd, 1998; Rosebery, Warren, & Conant, 1992). This type of instruction is especially promising for ELLs. Hands-on activities are less dependent on formal mastery of the language of instruction and, thus, reduce the linguistic burden on ELLs. Additionally, collaborative, small-group work provides structured opportunities for developing English proficiency in the context of authentic communication about science knowledge.

By engaging in science inquiry, ELLs also acquire English language and literacy while developing content knowledge in mathematics. Students develop English grammar and vocabulary, as well as familiarity with scientific genres of writing (Lee, Deaktor, Hart, Cuevas,
Additionally, science inquiry bridges authentic, communicative language activities and hands-on, contextualized exploration of natural phenomena, while promoting students’ communication in a variety of formats, including written, oral, gestural, and graphic. As part of science instruction, ELLs learn mathematics as they measure properties of objects and events (e.g., weight, length, and speed), use statistics and probability concepts for data analysis and interpretation, and learn how to record and present data in multiple formats. Students become precise and accurate in taking measurements, applying mathematical concepts, identifying patterns and anomalies in data, using multiple representational formats for data displays, and reasoning quantitatively. Thus, by integrating academic content across subjects, teachers can help students see meaningful connections and relevance among various subjects. An integrated approach is especially important for ELLs with limited access to science instruction in school (Amaral et al., 2002; Lee & Fradd, 1998; Stoddart et al., 2002).

Strategies to develop literacy and English language proficiency in content area instruction

Science learning and literacy development reinforce each other in a reciprocal process (Casteel & Isom, 1994; Lee & Fradd, 1998). Teachers may use various strategies to develop students’ literacy in the context of content area instruction, such as science:

- Read short stories or narrative vignettes to activate students’ prior knowledge on science topics
- Use narrative vignettes or expository texts related to everyday experiences to promote meaningful engagement and authentic communication
- Use specific comprehension questions about inquiry activities
- Use strategies to enhance comprehension of science information in expository texts at the end of each lesson
- Use a variety of language functions (e.g., describing, explaining, reporting, drawing concluding) in the context of science inquiry
- Engage students in whole-group, small-group, and individual reading on science topics
- Have students write an expository paragraph describing the scientific process under investigation
- Have students create Venn diagrams, concept maps, or graphic organizers using science vocabulary
• Have students record data and report results in multiple formats (oral, written, and graphic)
• Incorporate trade books or literature with scientific themes into instruction
• Use writing tasks as homework assignments; for example, students can write about what they did in class, share their writings with family members, write about what they talked about with family members, and finally, share their writings in class

In addition to developing general literacy with all students, teachers should consider the use of language support strategies with ELLs to enhance comprehension of academic content and to develop English language proficiency:

• Recognize students’ varying levels of language proficiency
• Structure activities to reduce the language load required for participation (e.g., slower rate, enunciation)
• Use language that matches students’ levels of communicative competence in length, complexity, and abstraction, such as reducing difficult language to key vocabulary or using shorter utterances and simplified sentence structures
• Communicate at or slightly above students’ level of communicative competence (i.e., comprehensible input)
• Use multiple modes of communication and representation through non-verbal (gestural), oral, graphic, and written communication
• Introduce key vocabulary in the beginning of lessons and encourage students to practice the vocabulary in a variety of contexts
• Use language in multiple contexts (e.g., introduce, write, repeat, highlight)
• Promote precision in describing and explaining objects and events, for example, give explicit attention to particular words, such as positional words (e.g., above, below, inside, outside), comparative terms (e.g., cold, colder, coldest), and affixes (e.g., /in-/ in “increase” or “inflate” as opposed to /de-/ in “decrease” or “deflate”)
• Use realia (demonstration of real objects or events)

**Home language and culture**  With ELLs, teachers need to understand how to use students’ home language in academic content areas. In science instruction, teachers may use key
science terms in students’ home language to enhance understanding, allow ELLs to discuss the lesson in class using their home language, encourage bilingual students to assist less English proficient students in their home language, or allow ELLs to write about science ideas or experiments in their home language (Lee, 2004).

Teachers should also consider students’ cultural experiences in relation to science. They could incorporate the ways students’ cultural experiences may influence science instruction; culturally-based ways students communicate and interact in their home and community; students’ lives at home and in the community; and students’ cultural artifacts, culturally relevant examples, and community resources (Barba, 1993; Lee, 2002). For example, teachers may use both the metric and U.S. units of measurement to incorporate the prior knowledge of students from different countries, and to help students understand the relation between the two systems. They may encourage a variety of group formations, so that students learn to work independently as well as collaboratively.

**Effective Assessment**

An important aspect of classroom assessment includes the use of meaningful and relevant topics, tasks, and activities. Teachers can employ assessment practices for ELLs, which may serve to benefit all students. First, using two separate scoring criteria, teachers may assess ELLs for science learning and English language proficiency separately. This assessment practice enables teachers to identify strengths and weaknesses of ELL’s in both science content and English language. Such scoring rubrics for science instruction are available (Fradd & Lee, 2000).

Second, teachers may assess ELLs in their home languages as well as in English. Allowing students to communicate science knowledge in their home languages promotes both general literacy and academic learning which, in turn, promotes English language proficiency. The emphasis on English language proficiency should not overshadow the importance of general literacy and academic learning. Achievement in these three areas can develop simultaneously (Thomas & Collier, 2001).

Finally, teachers should promote the use of multiple representational formats, keeping in mind that the goal is to move students toward established literacy standards. Those who
cannot write in either home language or English can express ideas in drawings or through oral communication. For example, a newly arrived Haitian elementary student, who had developed very limited literacy and had little schooling, had difficulty even holding a pencil. When he was asked to explain why a boat made of clay would float or sink, he became intently involved, gave explanations in terms of the air in the boat, and related this task to his perilous journey to the U.S. on a boat. Not only did the oral assessment allow him to demonstrate his knowledge of the topic, it made science come alive for him.

Summary
In addition to ensuring that ELLs acquire the necessary communicative language functions used for social communication, teachers must also create classroom conditions that promote ELLs’ development of general and content-specific academic language functions, such as describing, explaining, comparing, and concluding (Wong-Fillmore & Snow, 2002). Additionally, they must be able to view language within a human development perspective. Such an understanding enables teachers to formulate developmentally appropriate expectations about language comprehension and production over the course of students’ learning of English. Finally, teachers need to be able to apply this knowledge to the teaching of general and content-specific academic language. The amalgamation of these three knowledge sources should result in teaching practices that engage students of all levels of English proficiency in academic language learning; that engage students in learning activities that have multiple points of entry for differing levels of English proficiency; that provide multiple modes for students to display learning; and that ensure student participation in a manner allowing for maximum language development at their own level.

Conclusion
In any learning situation, students bring their previous experiences and prior knowledge related to the topic of study. In addition to learning academic knowledge, ELLs need to develop English proficiency and ways of communicating and interacting in the mainstream. ELLs with limited literacy or little schooling in their home countries also need to develop general literacy. Because of these multiple requirements, ELLs are more vulnerable to discontinuities that occur when educational policies and practices fail to meet their learning needs. Yet, ELLs bring cultural and linguistic resources that can be valuable in academic learning as well as in
general literacy and English language proficiency. However, these resources may not be easily recognized by teachers without specialized training.

It is a challenge for educators to recognize what linguistic and cultural resources the diverse student groups in their classes bring to the learning process and in what areas they need assistance. Teachers require professional development opportunities to gain deep and complex understandings of content area knowledge and to learn pedagogical strategies for promoting English language and literacy as part of content area instruction. Since educational policies for instruction and assessment in both content area teaching and ESL/ESOL/bilingual education influence classroom instruction, the support of school administrators is critically important. Eventually, ELLs learn academic content and process, while also mastering English as a new language.

Despite efforts to ensure that all students receive equivalent content instruction and fair assessment, opportunities to learn science may be more limited for ELLs than for English proficient students. Educators at all levels of the educational system should make efforts to provide resources and opportunities that meet the learning needs of all students, including ELLs. With creative and collaborative planning, much more can be done within the current system without excessively overburdening students or teachers. In providing accessible, high-quality content area instruction for all students, the education system will prepare students to become educated citizens and to participate effectively in a multilingual and multicultural society.

References


