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Teaching science to English only and limited English proficient students in the elementary classroom

Darla Kay Cadman Stapel

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TEACHING SCIENCE TO ENGLISH ONLY AND LIMITED ENGLISH PROFICIENT STUDENTS IN THE ELEMENTARY CLASSROOM

A Project
Presented to the
Faculty of
California State University,
San Bernardino

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts
in
Education: Elementary

by
Darla Kay Cadman Stapel
June 1994
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Approved by:

Dr. Ruth Sandlin, First Reader
Date

Dr. Iris Riggs, Second Reader
ABSTRACT

Statement of the Problem

The purpose of this project was to determine successful ways of teaching science to English only and limited English proficient students at the elementary level.

The quality of life in the 21st century will be greatly influenced by science and technology. Therefore, the writer of this project felt that more attention should be given to methods of teaching science in such ways that all children can understand, enjoy and be able to use it successfully in daily situations.

Procedure

This project is based upon a review of literature examining science education, language acquisition and best practices for teaching science to the English language learner.

Following the review of literature is a synopsis of the Science Framework for California Public Schools (1990) which emphasizes teaching by themes and using inquiry, hands-on type instructional methods. The framework also provides practical ideas for teaching science to language minority students.
Following the synopsis is a section on Cooperative learning. The benefits for teaching in cooperative groups is given as well as ideas for grouping, group roles, classroom setup, environment, techniques, and methods.

A thematic unit organizer is provided which is based upon the Outcome-Based Learning model by Jacqueline Rhoades and Margaret McCabe. A sample unit and blank organizer is provided as a guide for the reader in writing their own units.

Finally, a list of literature is provided which is available to aid in integrating science with other content areas, and which is approved by the Science Framework for California Public Schools (1990).
ACKNOWLEDGMENTS

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SECTION 1: INTRODUCTION

As the quality of life in the 21st century will be immensely influenced by science and technology, it is imperative that all people become scientifically literate (Encyclopaedia Britannica Educational Corporation, [hereafter denoted as Britannica], 1992). In order for future citizens to function in a technological society they will need to thoughtfully make decisions, have clear reasoning and have developed an ability to think about the scientific issues that face all of us (Britannica, 1992). John Dewey expressed that science "should take its rightful place in the center of the curriculum (as cited in Science Framework Addendum for California Public Schools, [hereafter denoted as Science Framework Addendum] 1984)."

Unfortunately, there are many limited English proficient (LEP) students in California that are not being taught in a way that it is comprehensible to them. Their lack of fluency in English has become a great handicap in their education (Pierce, 1991), including the important area of science (Dahl, 1989).

At this time, there are over 375,000 students in California public schools who have a limited English
proficiency. In addition there are another 433,000 students that can speak English fluently yet speak a different language in their homes. This makes the total number of language minority students in the California public schools enrolled in kindergarten through grade twelve nearly 810,000 (California State Department of Education Office of Bilingual Bicultural Education, 1987).

As a group, the language minority students do not perform as well as do native English speaking students in regular school programs (Dahl, 1989). Many of the language, academic and sociocultural skills that these students need in order to excel in vocational or higher educational pursuits are not acquired with sufficient competence to benefit the student. This usually results in very low levels of primary language proficiency and a less than standard ability to speak English when compared to the native English speaking student (California State Department of Education Office of Bilingual Bicultural Education, 1987).

Since science concepts are universal and have a common language, bilingual programs can easily take advantage of this commonality, allowing students to take part in science experiments and to develop their
oral language skills by explaining the incident to others (Science Framework Addendum, 1984).

Yet there is a documented lack of achievement of language minority students in math and science (Dahl, 1987). This underachievement begins in the elementary schools and continues on throughout high school. Dahl (1987) cites a report by the U.S. Department of Education (1981) stating that relatively low percentages of Black, Hispanic, and American Indian high school seniors complete advanced math and science courses.

It is likely that the underachievement of the language minority students in science is a direct result of teaching methods (Crandall, 1987), due to the lack of sufficient teacher education in both science and needs of limited English proficient students (Needham & Hill, 1979), limited materials and lack of administrative support (Dahl, 1987).

If schools are going to change this pattern of low achievement in language minority students, they must start in the early primary grades. Students need to be brought up to grade level in reading, science, and math during these early grades. They need to be exposed to instructional programs designed to stimulate and
develop their scientific curiosity, their powers of observation, and analysis, conceptualization, and generalization. This will prepare them to take advantage of the upper level coursework in science and math that currently is more readily accessible to other population groups (Dahl, 1989).

This project will explore practical ways of teaching science to English only and limited English proficient students at the elementary level. Its investigations will be based in part on the Science Framework for California Public Schools, (1990). It is hoped that this project will be of benefit to all teachers, especially to those teachers who only speak English, but have students in their classrooms whose primary languages are something other than English. If at all possible a bilingual teacher would be the ideal choice for students learning English, however reality has proven that most teachers, regardless of language will have students in their classrooms with a primary language other than English. The project will address: How can science be successfully taught in accordance with the Science Framework for California Public Schools to all elementary students, including those of limited English proficiency?
SECTION 2: LITERATURE REVIEW

SCIENCE EDUCATION

As the quality of life in the 21st century will be immensely influenced by science and technology, it is imperative that all people become scientifically literate (Britannica, 1992). A Nation at Risk (1983) proclaimed that American education has become victim to "a rising tide of mediocrity." (p.5) The report continued to say that it is becoming more and more obvious that the nation is facing a serious problem regarding both the quality and quantity of science instruction in the pre-college grades. Current studies comparing America's students to their international counterparts have placed them last in understanding science (Science Framework for California Public Schools [hereafter denoted as Science Framework], 1990). Confirmation of this problem can be seen in two areas: fewer number of students choosing the field of science, and low scores on standardized tests (South Carolina State Dept. of Education, 1990).

Lawson (1990), from Arizona State University, recently authored an article comparing science education in the United States with Japan. The article noted that Japanese students outperformed students from
the United States when both groups had been given the same assessment tool. Lawson (1990), uses several explanatory hypothesis explaining this result. The Japanese agreed with one of the hypothesis which suggests that their success in the area of science is related to a much greater emphasis on problem solving, open-ended, inquiry, and hands-on type instruction over memorizing and recalling facts from text books. When pressed for more opinions, the Japanese stated unanimously that the difference between learning and not learning reasoning abilities is in the way that science is taught (Lawson, 1990).

In a 1981 study, Hurd, Robinson, McConnell & Ross Jr. concluded, that in the United States "the common sequence of instruction today is to first assign, next recite, test, discuss the test, and then resort back to the textbook to ascertain why student performance was below expectation" (Bonja, Coogan, Lipman, & Rodgera, 1986 p. 2-3). William J. Bennett, U.S. Secretary of Education, in a report on elementary education, called for "revolution" in the way science is being taught in the elementary schools (Bonja et al. 1986).

To change this situation and revolutionize the way children are being taught in California, a new
framework for science has been written which emphasizes a thematic approach toward teaching science (*Science Framework*, 1990). The *Science Framework* also includes a "student-centered" science program as an essential part of teaching science. A program that allows for hands-on, inquiry type instruction, and in order "to be effective, should be enjoyable (1990)."

Japanese educators have already come to the conclusion that when children study science in the early years instruction should be "hands-on" and group "inquiry-oriented (*Lawson*, 1990)." The Japanese teach their children through first-hand knowledge of real objects. Children get their understanding from authentic sources with which they are allowed to experiment (*Lawson*, 1990). Douglas E. Lapp, Executive Director of the National Science Resources Center, contends that nothing can be more stimulating for children than hands-on, activity supported programs. He also commented that students are not interested in reading from science texts because the words are too difficult (*Bonja et al.* 1986). According to the *Science Framework* (1990), elementary school science programs must "reinforce conceptual understanding rather than rote learning". In order to do this, the
science programs must teach higher-level thinking processes that require in-depth investigations and real life experiences in the classroom (Science Framework, 1990).

The state of South Carolina provides its teachers with a resource manual addressing the needs of science instruction and how to meet those needs. To fulfill their science requirements, science education must encourage the use of the inquiry approach to science instruction (South Carolina State Dept. of Education, 1990).

With this philosophy in mind, Rutgers University has proposed the development of a teacher retraining center. Teachers would be trained by the University staff in teaching techniques involving process oriented inquiry learning (Bonja et al. 1986). Because the evidence continues to show the superiority of inquiry-oriented teaching methods over traditional methods, the hope of the teacher retraining center is to show that students can do better with inquiry based learning (Bonja et al. 1986). A revitalization in schooling is necessary to strengthen skills and raise the interest of elementary students and their teachers in respect to science (Bonja et al. 1986).
In order for today's students to be prepared to meet the challenges their future offers, it is necessary that elementary teachers build the foundation for all other levels. Teachers need to understand the process of scientific inquiry and have the skills to teach it to their students. This then will better help these students be prepared for the demands of the 21st century.

Research has shown that students using the inquiry method, and who also work in cooperative groups learn as well as those who work alone. An extra bonus for those who work together is to learn interpersonal skills and also a sense of group accountability (Jones, 1985). A considerable amount of research in the area of cooperative learning indicates that cooperation creates successful learning environments and fosters the accomplishment of most cognitive and affective outcomes (South Carolina State Dept. of Education, 1990).

Acknowledging the serious need to provide hands-on learning activities, some districts are offering a form of teacher retraining. One teacher retraining center has been opened on the Cook College campus of Rutgers University (Bonja et al. 1986). This retraining center
provides opportunities for teachers to learn about the inquiry method of teaching and allows the teachers to use its materials to facilitate the transition from traditional teaching to inquiry based teaching (Bonja et al. 1986). Although Rutgers University and some districts have begun retraining centers for teachers learning the inquiry approach, it should be noted that by in large few retraining programs exist for training or retraining teachers in the inquiry approach.

Because of this lack of training or retraining as the case may be in the inquiry approach some people are observing that it is rarely used in the classroom. Bonja et al. (1986) cites an article by Costenson and Lawson entitled, "Why Isn't Inquiry Used More in the Classroom?". A few of the most commonly cited reasons for not using inquiry in science instruction are time and energy, the process being too slow, student immaturity, and teaching habits that were too well patterned in existing approaches.

In addition to providing teacher retraining and making materials available, school principals should create an environment which allows teachers to implement new programs, then the quality of what occurs can remain over a long time (Dahl, 1989).
When asked the question "Why inquiry learning?", educators can answer that group inquiry-oriented and hands-on type learning make the difference between the development of cognitive skills in science and reading the textbook "which most science educators would not view as teaching science at all (Lawson, 1990)."

The next section of the literature review will cover language acquisition, followed by a section relating language acquisition with science instruction.
LANGUAGE ACQUISITION

There are currently over 375,000 students in California public schools who have a limited English proficiency. In addition there are another 433,000 students who can speak English fluently yet speak a different language in their homes. This makes the total number of language minority students in the California public schools enrolled in kindergarten through grade twelve nearly 810,000 (California State Department of Education Office of Bilingual Bicultural Education [hereafter denoted as Office of Bilingual Bicultural Education], 1987).

The considerable difference between standardized test scores of minority and majority students and by the persistently high rate of school suspensions and dropouts among Black and Hispanic teenagers is a demonstration of the fact that minority students are experiencing low academic achievement (Pierce, 1991).

There are a myriad of reasons for this underachievement of minority students, but whatever the reasons, research on effective schools shows that schools can and do make a difference in the academic success of these students (Pierce, 1991).

The Office of Bilingual Bicultural Education
(1987) has established three main goals for all instructional programs serving language minority students. These goals are: 1) academic proficiency in all dimensions of the English language, 2) academic achievement in all subject areas, and 3) self-esteem, and pride in one's language and culture.

According to Dr. James Cummins (1987), there are two elements of language proficiency. The first is known as basic interpersonal communicative skills (BICS), which are the simple skills required to communicate with adults and peers at home, play, school, or other settings. The second element of language proficiency is the cognitive academic linguistic proficiency (CALP), which is the language ability needed for formal learning and literacy activities. CALP requires higher levels of cognition and abstract thinking (Cummins, 1987).

Student skills must be carefully assessed even if they appear to speak English fluently. It should not be assumed that such a student has the necessary skills to succeed in an all English class (Pierce, 1991). A student's ability to use native-like "conversational English" (BICS) does not mean that he or she is strong in the academic language (CALP), and care should be
taken in the classroom placement of the student (Cummins, 1987).

There is a risk of inappropriate teacher expectations and unfair classroom placement when language minority students are placed in all English classrooms on the basis of conversational skills (BICS) alone (Pierce, 1991).

Research on second language acquisition shows that learning is most effective when it is comprehensible to the learner (Krashen, 1985). There are two types of processes by which someone may develop communicative competency in a second language—learning and acquisition (Office of Bilingual Bicultural Education, 1982).

When formally learning a language, the student is actually conscious of the learning taking place. Rules are taught, practiced and memorized. Second language acquisition is different in that it is more of a subconscious means whereby one acquires the second language similarly to how the first language was acquired (Krashen, 1981).

In order for limited English proficient students to acquire language in the classrooms today, it is necessary for them to receive their instructions in
such a way that everything is comprehensible to them (Krashen, 1981). According to Krashen (1981), "comprehensible input" is the receiving of instructions in such a way that the students understand and yet are challenged to progress one step above where they currently are. The environment should be such that there is low anxiety, high motivation, and confidence in oneself (Krashen, 1981).

Methods for teaching LEP students are varied and change with the times (Chamot & McKeon, 1985). There are two kinds of second language instruction today; communicative and grammar-based (Terrell, 1987). Communicative instruction involves goals, teaching styles, and student evaluations, with its main objective, being communicating messages. Grammar-based instruction involves goals, teaching styles, evaluations, with its main objective being accuracy in the grammar usage (Terrell, 1987). According to Terrell (1987), grammar-based instruction has found its success when the goal is to produce grammatically correct sentences "in a limited communicative context." Communicative-based approaches have been very successful overall because of the instructional goal of meeting the practical communication needs of the
Professional literature reports many communicative strategies: Lozanov's Suggestopedia, Curran's Community Counseling-Learning, Galyean's Confluent Education, Terrell's Natural Approach, (Terrell, 1987) and Asher's Total Physical Response (Chamot & McKeon, 1985). All of these approaches have been or are being used by practitioners today to teach English as a second language. The teacher must decide in each situation which approach will be the most effective for each teaching situation (Chamot & Stewner-Manzanares, 1985).

Although there are many communicative approaches for teaching English as a second language, this paper will only review the two that appear to be the most beneficial in science instruction as well as English as a second language. The Natural Approach and Total Physical Response. The Natural Approach is based upon the work of Tracey Terrell and Stephen Krashen (1987). They suggest techniques that encourage the natural acquisition of language as opposed to teaching a language outright (Chamot & McKeon, 1985). According to Terrell and Egasse (1977), the acquisition of language will take place only if the following
conditions are met; 1) attention is focused on the message and not on the form, 2) some kind of communication takes place, and 3) the student must not feel stress or emotional tension. According to Terrell (1987) the Natural Approach in teaching Basic Interpersonal Communication Skills employs two main principles: "(1) Speech is not taught directly but rather is acquired by means of comprehensible input in low-anxiety environments, and (2) speech emerges in natural stages" (p. 119).

Total Physical Response (TPR) is an approach developed by psychologist James Asher as a technique for second language acquisition which follows the first language acquisition sequences (Chamot & McKeon, 1985). Asher's approach is developed upon three key ideas: 1) understanding the spoken language comes before speaking the spoken language; 2) understanding occurs through the students' moving of their own bodies; and 3) we cannot force children to speak; speech comes when they are ready (Asher, 1977).

Pierce (1991) in her research cites Garcia (1987) as indicating that second language learning is most effective when it incorporates the following procedures.
• Emphasizes authentic communicative learning situations, as opposed to learning about language and its parts.
• Makes the English language "comprehensible" and meaningful to limited-English proficient students, as opposed to involving meaningless drills and repetition.
• Minimizes anxiety and frustration by reducing error correction and encouraging second language learners to take risks and make mistakes a natural part of language learning.
• Minimizes linguistic and cultural segregation of second language learners by providing opportunities for interaction with native speakers of English.
• Maximizes use of basic cognitive mechanisms, such as learning strategies, hypothesis-testing and revision, generalization, and problem-solving, as opposed to concentrating on development of specific linguistic skills. (p. 12)

As research has shown, much of the above procedures can be achieved through cooperative learning activities which in turn can have positive results when used with language minority and limited English
proficient students (Pierce, 1991). Cooperative learning, peer and cross-age tutoring can have positive effects on academic achievement with LEP students as well as cross-cultural relations between students (Pierce, 1991).
REVIEW OF SCIENCE AND LANGUAGE ACQUISITION

Dahl (1989) reports a documented lack of achievement of language minority students in math and science. This underachievement begins in the elementary schools and continues on throughout high school.

If schools are going to change this pattern of low achievement in language minority students, they must start in the early primary grades. Students need to be brought up to grade level in reading, science, and math during these early grades. They need to experience instructional programs designed to stimulate and develop their scientific curiosity and their skills of observation, analysis, conceptualization, and generalization. This will prepare them to take advantage of the upper level coursework in science and math that currently is more readily accessible to other population groups (Dahl, 1989).

Teaching English through content instruction is one way that teachers can reach language minority students and improve their communication skills in English as well as their academic proficiency. Numerous members of the teaching profession have recognized the importance of centering on content as
well as language (Crandall, 1987). An excellent method for teaching social interaction and enhancing second language acquisition is a process-oriented science class which utilizes the inquiry approach (Kessler & Quinn, 1984).

Needham and Hill (1979) cite Eggen, Kauchak, and Harder (1979) as saying that a common problem in schools is teachers giving students symbols to learn, but not providing experiences which produce understanding. The consequences of this type of teaching are that concepts are only learned as names or words rather than having some kind of meaning for the students.

For second language learners, an inquiry approach to science education is critical, especially when compared to the traditional textbook-oriented approach (Kessler & Quinn, 1984). One type of inquiry learning is known as "Cheche Konnen" which is a Haitian Creole term meaning "search for knowledge." The Cheche Konnen method of teaching science involves active inquiry, student collaboration, and interdisciplinary learning. It involves limited English proficient students in scientific activities which are relevant, meaningful, and academically demanding (Rivera &
Children are naturally curious about their environment. The inquiry method with hands-on instruction allows the children to focus on science issues that they are already motivated to learn about. It helps them to take ideas that they have already constructed from their life experiences and find how those ideas fit in with a scientific view and whether they need to modify, extend, or replace their view with a more scientific view (Needham & Hill, 1987).

Emphasis on inquiry helps students to learn more about the "how" of science rather than the "what". It helps them comprehend that science is not something static out of a textbook, but rather a "dynamic quest" (Kessler & Quinn, 1984). Overdependence on textbooks only gives students exercises in literacy encouraging misunderstandings about science. "For second language learners, dependence on textbooks in preference to hands-on investigation seriously constrains the conditions that facilitate language development" (Kessler & Quinn, 1984 p. 64). Reading from a textbook that they do not understand and having no interaction with others to gain meaning will not help to improve language acquisition (Kessler & Quinn, 1984).
A distinction must be made between a lab-based inquiry approach where the teacher demonstrates, and actual hands-on inquiry, where the students are doing the investigations, therefore interacting, communicating and acquiring language (Kessler & Quinn, 1984).

Rivera and Zehler (1990) report that researchers of Cheche Konnen analyzed their own data concerning Cheche Konnen and their analysis led them to conclude:

Knowledge, or what students learn, is inextricably tied to the ways in which it is learned... robust learning, whether in a discipline such as science or in language, grows out of purposeful engagement with complex, ill-defined problems rather than mastery of oversimplified and decontextualized facts and procedures. (p. 17)

Science is unique in that it is one of the few curricular areas that emphasizes and encourages hands-on experimentation (Kessler & Quinn, 1984). Present inquiry programs emphasize the cognitive processes of observing, inferring, predicting, hypothesizing, and experimenting. This provides a healthy environment for understanding science and acquiring language (Kessler & Quinn, 1984).
It is considered to be the inquiry approach to teaching when children are required to go beyond the given information to gain new understanding, and when they are problem solving, looking for answers—or at least generalizations (Esler & Esler, 1989). Given the opportunity to problem-solve and investigate together, the students are not only learning science, but great effort goes into converting these experiences to language (Kessler & Quinn, 1984).

The language of science is complex, and more research is necessary to investigate its relationship to the language minority student who is studying science. There are, however, several very basic rules to follow when teaching LEP students. The first rule is that acquisition of new terminology will not occur through rote memorization of isolated lists. Instead, it needs to be presented in a science context. Secondly the more students are actively engaged in a hands-on type project which involves talking about ideas, the sooner the science language will be acquired (Kessler & Quinn, 1984). Through the inquiry process in science instruction, language in general will be developed from the communicative context in which it is used (Mohan, 1986).
When students are involved in science, and not just reading science books, the focus is on the events taking place. Language begins to evolve out of a need to relate observations or communicate aspects of the investigation to others. The students are focused on what is being said, not how it is being said. Errors in language can be ignored as long as they do not interfere with communication (Kessler & Quinn, 1984).

Science, when taught as the inquiry, laboratory approach method, provides ample opportunity for student interaction. This type of involvement gives sufficient structure and management to make conditions possible for second language development even when the numbers of LEP students in the class are very high. Despite the fact that the socialization is only with LEP students, the quantity and variety of language practice help to aid in language acquisition (Kessler & Quinn, 1984).

As the scientific illiteracy rate continues to grow in California, it becomes imperative that science educators ensure that all students have an equal opportunity to succeed in science related fields. "This state cannot afford a citizenry or work force composed of individuals lacking the scientific literacy
to compete in a technologically sophisticated economy" (Science Framework, 1990, p. 167).

"All children in California, including those whose primary language is other than English, should have access to high-level science instruction" (Science Framework, 1990). All students can learn the science content, even those who are limited English proficient, the problem is not one of capability; it is a problem of how the content is delivered (Science Framework, 1990).

Science instruction can be meaningful and help students acquire language at the same time, if it will employ techniques that are comprehensible to the learners; techniques which are built upon good teaching in general, and specifically, good science teaching.
SECTION 3: STATEMENT OF GOALS AND OBJECTIVES

A goal of this project was to give a brief overview of the Science Framework for California Public Schools (1990). This synopsis serves as the guideline for what science should be taught and how it should be taught in elementary schools in California with emphasis on, and ideas for teaching Limited English proficient (LEP) students.

The second goal of the project was to present Cooperative Learning as an effective vehicle for teaching science, as well as other curricular areas to all students, including LEP students.

A third goal of this project was to provide teachers with ideas on developing units by themes as recommended by the Science Framework. A rational is provided for the unit organizer used in this project. A template of the unit organizer, and a sample unit is provided.

A final goal was to supply a reference list of available literature which meets the criteria presented in the first part of the project, and which are also approved by the Science Framework.
SECTION 4: DESIGN OF THE PROPOSED PROJECT

This project is divided into four parts: part one is an overview of the Science Framework for California Public Schools (1990); part two presents Cooperative Learning as a technique for teaching science and LEP students; part three helps teachers begin designing their lesson plans by thematic units as recommended in the Science Framework and part four supplies a literature list of available/recommended literature which meet the criteria as addressed in the Science Framework for California Public Schools (1990). Included with the project as its final section are the questionnaire and evaluation forms that will be used by those elementary teachers in Southern California who will field test the project.

The first part of this project gives a brief overview of the Science Framework for California Public Schools (1990) as it pertains to elementary school teachers. It is presented in a narrative form which gives content, concepts and methods to be taught in the elementary schools, concluding with specific ideas for teaching Limited English proficient (LEP) students.

The second part of the project presents Cooperative Learning as a vehicle for teaching students
and helping them to learn interpersonal skills as well as group responsibility. As cited earlier, cooperative learning is an effective tool for teaching science to LEP students.

The third part of the project is designed to help teachers begin teaching by themes as recommended by the Science Framework. A rational is given for choosing Outcome-Based Learning as the thematic unit organizer. This type of unit is to be kept in alignment with the Science Framework, i.e., Content, concepts, and the hands-on approach which will help students learn the science content presented in the Science Framework for California Public Schools (1990), while at the same time acquiring English language proficiency. A sample unit with a template for writing new units is provided in Appendix 1. This unit is not intended to limit teachers, but to give an example of an integrated, hands-on science unit adapted specifically for the English Language Learner (ELL).

Finally, a list is provided of literature which is available to aid in integrating science with other content areas, and which are approved by the Science Framework. This list can be found in appendix 4.

The project will be evaluated by other Southern
California elementary teachers with LEP students. A questionnaire will be given which asks them to rate the usefulness, effectiveness, and ease of implementation of the project.
IMPLICATIONS FOR TEACHING

This project is designed primarily for elementary teachers in California, as it follows the guidelines set forth in the Science Framework for California Public Schools (1990). It was designed specifically to help educators, who may or may not speak English, teach science to students who are limited in their English speaking proficiency.

Even though it is based in part upon the California science framework, primary teachers from other states will find this project helpful. For science content they should consult their own state's frameworks before implementing this project.

The project's two main areas of focus are: 1. Teaching science in effective ways. Current literature reports this to be accomplished in a hands-on, inquiry type approach; and 2. Effective English as a second language instruction within the context of science.
REFERENCES


Costenson, & Lawson. Why isn't inquiry used more in the classroom?


INTRODUCTION TO HANDBOOK

The purpose of this handbook is to help teachers successfully teach science to Limited English Speaking (LEP) students as well as to their English only speaking peers. The handbook is designed specifically for teachers who do not speak the primary languages of the children they may have in their classrooms. It begins by reviewing the Science Framework for California Public Schools (1990) and shares this framework's stand on science and how it should be taught. Included are ideas and techniques specifically designed to help make the English language comprehensible for all English Language Learners (ELL).

Following the Science Framework is a section on Cooperative Learning. This cites the importance for cooperative groups in science class as well as for helping ELL students understand the English language.

A sample unit is provided which gives concrete examples of hands-on, inquiry type science activities set in a context which is designed to facilitate English language acquisition for ESL students. Again more strategies and ideas are provided which are geared towards English comprehension for ESL students.

A section is included which provides literature,
both fiction and non-fiction, which can be used in integrating science with other content areas as well as aiding in English understanding for English language learners.

Included in the handbook are questionnaire and evaluation forms that will be used by those elementary teachers in Southern California who will field test the handbook.
According to the 1990 publication of the Science Framework for California Public Schools, teachers in the elementary school science program can capitalize on the curiosity children have about their world, and use this eagerness for learning in ways that make science enjoyable, interesting and meaningful. A purpose of the Science Framework is to provide educators with a guide for teaching science in the classroom. Not only does it define science but it also gives ideas of what should be taught, how to teach, curriculum design, and staff inservice. It contains many new ideas and encourages teaching science in themes. It also contains a section geared towards reaching all students.

This section begins by stating that the populations of minority and at risk students in California are increasing along with the number of dropouts and graduates without solid backgrounds in science. It continues on to say that "as women and minorities become larger segments of the California work force, they are less well represented in the fields of science and technology." Science educators therefore must ensure that all students have an equal
opportunity to succeed in learning about science and using science in their lives. The following are recommendations from successful professionals who believe and demonstrate that all children can learn:

1. Model positive attitudes about all students' successes in mathematics and science.
2. Prepare students well in the areas of mathematics and language arts.
3. Provide enrichment opportunities in mathematics and science for females, minority students and students with disabilities.
4. Build parent involvement and peer recognition programs.
5. Capitalize on students' prior knowledge.
6. Maintain the same standards for all students.

The Science Framework continues on to give specific recommendations for teaching Limited-English proficient (LEP) students.

All students with an LEP designation should have "rigorous" English-as-a-second-language (ESL) instruction. This ESL component will help to build a strong foundation in English which will be necessary when the point in time arrives that all content instruction is given solely in English. ESL classes
might integrate some science vocabulary into the activities, thus providing more support into the science classes. It is important however, to understand that ESL classes are for English language acquisition and not for learning science content.

Science instruction alone can be meaningful for the LEP students if appropriate strategies are used to make instruction comprehensible. The science content is not simplified in any way, but the method of delivery is changed in order to make the information comprehensible. These strategies are based upon good teaching in general and good science teaching in particular.

1. Simplify the input: Slow the speech down and enunciate the words clearly. Resist the temptation to turn science into a vocabulary course. Use proper science terminology, restate, redefine, give examples and utilize students' prior knowledge.

2. Provide context clues: Use gestures, act out the meanings. Use realia whenever possible as well as graphs, visuals and other props. Demonstrate, act out and provide samples when possible.

3. Draw on prior background: Students can brainstorm ideas (be prepared for short answer or one
word responses). Use graphic organizers and provide multisensory activities.

4. Work to ensure understanding: Provide opportunity for interaction between students and teacher as well as students with other students. Repeat, restate, expand and reinforce important points.

5. Make sure instruction is content-driven: Identify the key concepts and prepare to teach those few ideas well instead of covering a large amount of material superficially. Depth and understanding are more important than width.

6. Ensure that instruction is student-centered: Instructional strategies could include small-group, large-group, and cooperative grouping. About 40 percent of instructional time should be with direct experience. Students should be allowed to manipulate materials. A demonstration in front of the students is not as effective as actual hands-on opportunities.

7. Use science text effectively: When using a science text select the essential vocabulary and teach it through a variety of techniques. Begin a new chapter with an activity, even if it is located later on in the chapter.

It is important that all students have access to
quality science instruction. Using these kinds of techniques to reach LEP students will ensure access for all students, including those who are not LEP designated. "Rather than trying merely to cover the content, we should uncover science content."

The Science Framework contains a section which is geared toward the elementary schools. It explains the great potential for exploring technological applications and natural phenomenon of science in the elementary classroom.

According to the Science Framework, elementary science programs should:

1. Provide a balanced curriculum in the physical, earth, and life sciences. Each subject should be given the equivalent of one-third of the total class time in each year and should involve activities where children are "doing science."

2. Show students that science is enjoyable. Because students are curious about their world and are eager to learn, teachers can continue to motivate learning by "modeling a fascination with science and its dynamic presence in our daily lives."

3. Reinforce conceptual understanding rather than rote learning. This requires more in-depth experiences
in the classroom as opposed to lower-level recall type activities. The students' conceptual understanding can be enhanced when students are helped to draw connections between their own experiences, unique situations and previously learned ideas.

4. Organize an articulated scope and sequence at the school level. This implies that principals, teachers, other school site leaders, and parents should plan a sequence of units which involve a significant portion of the total science curriculum. The curriculum can then be divided according to grade levels, whereby each grade is teaching the three disciplines by way of the units which have been created. It should be noted that 40 percent of the total time spent learning science should be in activity-based lessons.

5. Arrange the classroom setting and student grouping to optimize positive attitudes for learning science. There are many ways to transform the regular classroom setting into one which is optimum for fostering curiosity and a desire to learn more science. Desks or tables can be arranged to encourage small-group work on science activities. Science equipment, reference books and other science related literature
should be within easy access to students. Bulletin boards and study areas in the room can be organized in such a way to make it clear that science is important and accepted in the classroom. "Students should have opportunities to work in cooperative groups, perform investigations, manipulate science equipment, and follow safety precautions." The groups should then be held accountable for their learning.

6. Integrate science with other subjects.
"Scientific literacy could receive a considerable boost if science were used as a vehicle to enhance reading, mathematics, and the arts." (p. 161) "Science reading should be encouraged and integrated in the overall curriculum." (p. 161) It is emphasized however, that science maintain its "rigor and uniqueness" as its own field of study, and that it not get lost in an effort to integrate with other disciplines.

7. Make full use of community resources.
Community resources can be a very helpful way of bringing science into the classroom or to serve as field trips. Many students who may not have opportunities to experience science outside of the school can be greatly enriched by community agencies and their personnel, as well as others from the
community (pp. 161-162).

The **Science Framework** is different from previously written frameworks in that it is centered around themes of science. Themes in this context meaning the broad, large ideas of science, not just facts, units or separate concepts. This could be related to a broad umbrella under which the basic data and evidences of science are encompassed and connected.

The **Science Framework** has developed six major themes: (1) energy; (2) evolution; (3) patterns of change; (4) scale and structure; (5) stability; and (6) systems and interactions. These themes are continually reoccurring in scientific studies and educators are strongly encouraged to incorporate these themes into their curricula. The **Science Framework** stresses that these are not the only themes that can be used when developing science material, but that the important point is that there is some thematic structure which will unite the otherwise disunited scientific facts. "The main criterion of a good theme is its ability to integrate facts and concepts into overarching constructs" (p. 2).

As explained by the **Science Framework**, the processes that scientists use in their everyday work
are: observing, communicating, comparing, ordering, categorizing, relating, inferring, and applying. As these are important processes used by scientists today, it is understandable that these are the processes that educators should center their instruction on, especially hands-on instruction.

The Content of Science Grades K-6

Physical Science:
1. Matter
2. Reactions and Interactions
3. Force and Motion
4. Energy: Sources and Transformations
5. Energy: Heat
6. Energy: Electricity and Magnetism
7. Energy: Light
8. Energy: Sound

Earth Sciences
1. Astronomy
2. Geology and Natural Resources
3. Oceanography
4. Meteorology

Life Sciences
1. Living Things
2. Cells, Genetics, and Evolution
3. Ecosystems

The following suggestions have been given by the Science Framework to help teachers use students' previously formed ideas as a "springboard" for learning new concepts.

1. Ask questions to ascertain what ideas the students may hold about a topic before beginning instruction.

2. Be sensitive to and utilize the differing experiences and conceptions that children have about science.

3. Use a wide variety of instructional strategies to enhance understanding.

4. All students must be allowed to share in discussions and cooperative learning situations.

The Science Framework quotes the educational maxim that "learning by doing is the most effective instructional paradigm." If children are going to learn, they must be provided with opportunities to conduct hands-on investigations. These investigations need to be carefully organized and should place students in a position of responsibility/accountability for learning. The hands-on activities need to be designed in such a way that they are important and
relevant to the students involved.

In summary, the Science Framework for California Public Schools calls for a "new dynamic science learning." Learning where students can be actively involved in their education. This "active learning" can be in the form of actual hands-on investigations where their five senses are being utilized, active reading, listening, discourse, and using new learning technologies. The important factor for active learning is that students are able to make associations between new ideas and their previous conceptions of how the world works. Bill Honig, State Superintendent of Public Instruction in his Foreword for the Science Framework concludes with this thought. "We can perform no better service than helping all students share in the science-rich heritage that defines California."

The Science Framework for California Public Schools is a document that will help all students share in the science rich heritage that is a part of not only California but our whole world.
COOPERATIVE LEARNING

"Research shows that students who work in groups learn concepts just as well as those who work individually, with the added bonus that students who work together can develop both interpersonal skills and a sense of group responsibility (Jones, 1985 p. 21)."

Cooperative Learning has been an instructional model formally since the mid-sixties, however it is not "new" since the sixties. Its "formal" beginnings can be found in the works of such men as John Dewey, Kurt Lewin, George Herbert Mead, Harry Stack Sullivan, Morton Deutsch and others (McCabe & Rhoades, 1989). As mentioned earlier, research does indicate that students have a tendency to learn more when cooperative learning methods are applied in the classroom. Increases are seen in academic achievement, self-concept, interest in learning, and teachers are experiencing fewer discipline problems (McCabe & Rhoades, 1989).

According to David and Roger Johnson (McCabe & Rhoades, 1989), "Higher achievement is not the only reason for using cooperative learning." (p. xiii) The quality of life in classrooms is enhanced when cooperative learning dominates as opposed to competitive and individualistic learning. A community
of learners is developed with students who are happy to be in the room knowing that others are there who care about them as a person and who are willing to help them learn. Students develop friendships regardless of "ethnic and cultural differences, differences in primary languages, and whether they are handicapped or nonhandicapped." (p. xiii) Johnson and Johnson (1989) continue to say that the benefits of cooperative learning do not end with the classroom, but provide basic life survival skills which are carried over into students' non-academic lives. "There is some evidence that grades in school are not correlated with career success or with quality of life as an adult." (p. xiii) Social skills are what is needed when it comes to getting and keeping a job, they (social skills) are also what is necessary for positive personal and family life. Training in cooperative learning will help teachers to help children prepare themselves for these important life skills.

Cooperative learning is a method used today to teach social skills, ie: social responsibility, while at the same time teaching academic content (McCabe & Rhoades, 1989). It is an evolving process which takes time and cannot be implemented in an hour block between
first and second recesses.

According to the Johnson brothers (David & Roger Johnson 1975/1987) there are three fundamental classroom goal structures:

* Independence - where each child must work independently and each can get an A regardless of what the others do.

* Negative Interdependence - where success of one is dependent upon failure of another. This is the typical classroom where teachers give only a certain number of As and grade on a curve.

* Positive Interdependence - where students are placed in a situation where success is dependent upon each other. The Johnsons say it like this, "We sink or swim together."

"All three of these goal structures are useful under certain conditions. You need to develop awareness of which is the most appropriate goal structure to use in any given situation, and how to mix these so as to create variety and interest within your classroom (Graves & Graves, no date, p. 2)."

The most preferred technique for promoting positive interdependence is to divide students into small learning teams of two to six and then giving them
a common goal: "To produce a single report, project, poem or play; to conduct an experiment or solve a problem; to agree on a single answer to some question or fill out a single worksheet; or to collaborate to produce some other form of team product (Graves & Graves, no date, p. 2)."

Before giving a brief explanation of how to implement cooperative learning in a classroom, it might be helpful to consider "Why?" implement cooperative learning.

Studies have shown that employers complain that young people have little or no initiative, are not dependable, and cannot get along with their fellow workers, supervisors or consumers (McCabe & Rhoades, 1989). McCabe & Rhoades (1989) continue to further state that:

During the last several years, major studies have consistently concluded that human interaction skills such as effective communication, problem solving and conflict management; a knowledge of and ability to function effectively within small and large groups and an ability to identify and utilize resources whether they be intellectual,
informational or recreational are the skills
we need for a successful future society. Our
citizens must possess a sense of
responsibility for self and others; they must
be dependable and they must be able to use
their own initiative if they are to be
successful. (p. 6)

This clearly shows the importance of social skills
in every aspect of life. There will be few, if any,
jobs that are completely isolated from others, and all
of us need practice in social skills to be able to cope
with our own personal lives as well as family.

The following paragraphs of this essay will
discuss effective ways educators can teach cooperative
skills to their students so that in collaborative
groups they can realize a common goal.

When teaching cooperative skills it is very
important to first establish a safe environment, one in
which students are not afraid to take risks. Setting
standards will help the students understand what is
expected of them which in turn lessens the anxiety some
may feel.

Getting acquainted activities will help the
students get to know each other as well as the teacher,
and the teacher to become acquainted with the students. Extensions of getting acquainted activities are transition and energizing activities which refocus students' attention and energies at the beginning of each day, after lunch, recess or breaks (McCabe & Rhoades, 1989).

Cooperative learning uses small, collaborative groups in which students work and complete assignments together. In order for the group to function as smoothly as possible it is important to assign group roles. It is important to teach each role and its function to the students. Students need ample opportunities to learn and then practice each role. The following is a possible list of group roles given by Sam Crowell, Professor at California State University, San Bernardino, Spring Quarter, 1993:

* Facilitator - (King maker) - Keeps the group interaction alive. Makes sure everyone has the opportunity to be involved. This particular role may include the role of "starter."

* Equipment coordinator - This is the person who is responsible for retrieving all materials and taking care of them. This person is also accountable for all materials at the end of the cooperative activity.

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* Monitor/Processor - This person is responsible for processing what the group is doing or has done.

* Work Assistant - It is the responsibility of this person to see that work is being done. May include passing papers, summarizing, collecting, organizing, and helping.

* Presentation Coordinator - It is the responsibility of this person to present to the class or other group the "product" of their group.

Another role which has been found to be effective is the role of Praiser. This person is the one who makes sure that all students are using encouraging words and keeps the atmosphere on a positive level.

Grades and awards are also an important part of cooperative learning. Individual grades/awards may given as well as group grades/awards. McCabe and Rhoades (1989) give a caution on group grades and think it especially important to talk with supervisors and parents first. Some parents, especially those of high achieving students often do not want their children's grades based upon group work.

It should be emphasized that in cooperative learning the role of the teacher is changed. The teacher no longer stands in front of the group to
disseminate knowledge, but rather is a facilitator that is a mediator between the learner and material. There are times when the teacher does have the role of "teacher as expert", but this is not the exclusive role of the teacher.

Jones (1985) in his article entitled Teaming Up has given some good ideas for cooperative classrooms which he calls "Tricks of the Trade". These suggestions are designed to help educators implement effective cooperative groups. They are as follows:

1. Let each group choose a name for itself.
2. Change group members from time to time.
3. Talk only to the facilitators about the activity.
4. Employ both indoor and outdoor activities.
5. Use groups of three when working outdoors or on a field trip.
6. To ensure clear communication, post class rules, group names, job descriptions, and any other important information on a bulletin board in the classroom.
7. Develop a system for rotating roles.
8. Use the job descriptions for classroom management and discipline.
9. Develop a worksheet, data recording sheet, graph, or some other instrument for each activity.

10. Make yourself a badge and join in the fun.

Finally, it is important to understand that the room arrangement will be different in a cooperative classroom than that of a traditional classroom. The ideal situations are groups of moveable desks, small round tables, and sitting in circles on the floor. However, budgets may not allow for this, so keep the following factors in mind when students are working together:

- Students must face each other. Group members need to see and hear each other.
- There should not be any empty places or chairs within the group.
- Group members should be close enough to each other to speak softly and be heard.
- The area in which each group is working should be void of any distracting materials.

When it is time for groups to move to their area or work station, it is important to:

- Give very clear directions.
- Have each group move immediately after you advise them of their work location and before telling the
next group. Or, tell the groups that no one moves until you give a signal.

-Keep the actual movement of furniture at a minimum (McCabe & Rhoades, 1989, pp. 235-236).

In conclusion, cooperative learning is a widely used technique for teaching not only academic skills, but social skills as well. "The benefits of cooperative learning do not end at the close of the school day or school year. Cooperative learning provides an arena in which basic life survival skills are mastered" (McCabe & Rhoades, 1989, p. xiii).
ORGANIZING UNITS BY THEMES

Before educators begin to organize and plan their units, they need to focus on their purposes for teaching the unit. What is it that they (teachers) expect their students to learn and be able to do as a result of the unit. Setting these kinds of goals, will help teachers plan more effective units which in turn will help students connect new information to larger ideas (themes) which are recurring in life. "Themes are necessary in the teaching of science because they are necessary in the doing of science. A scholar does not merely collect facts and categorize them. Facts are useful only when tied to ... larger questions." (Science Framework, p. 27.)

According to Rhoades & McCabe (1992) "This is a time of transition in our educational system, in the beliefs, premises and practices that have been held dear for decades. The assumptions underlying the process and content of educational programs are changing and a major paradigm shift is occurring." (p. 1)

From the time our school system was first begun, our society has evolved from an agricultural base to an industrial base and finally to an information base.
Unfortunately many schools are still functioning at the industrial (factory) model, despite evidence that this method of instruction is no longer preparing students for success in the world. According to Rhoades & McCabe (1992) there are some important considerations to ponder concerning education:

1. Information is doubling and tripling every two to five years. In some fields of study information doubles in less than a year.
2. Often what we believe to be a fact today will not be true next month or tomorrow.
3. At least half of the occupations our kindergartners will enter do not exist today.
4. We can expect to change careers five to seven times during our lifetime.
5. Our rapidly changing society requires that we continue to learn throughout our lives. Our students cannot graduate from high school, expect to get a job and stay with that job for the rest of their lives.

Just as society is changing, so is the field of education. There is a great deal of controversy as to which direction we should focus the change.

Cooperative Learning and Outcome-Based Education (OBE)
are two practices that have gained an intense interest by those interested in creating change.

Transformational outcome-based education as conceived by William Spady is based upon three premises: "All students can learn, success breeds success, schools control the conditions of success" (Spady & Marshall, 1991, p. 67). Jacqueline Rhoades and Margaret McCabe (1992) have taken this OBE philosophy, integrated it with cooperative learning and have developed a unit/lesson design which they have called Outcome-Based Learning (OBL). Outcome-Based Learning takes the theory and philosophy and moves it into a practical design that can be used successfully in developing thematic units.

Outcome-Based Learning offers processes and strategies which are necessary for success in life (Rhoades & McCabe, 1992). Outcome-Based Learning:

- Focuses on the classroom.
- Strongly advocates interdisciplinary curriculum.
- Relies on authentic tasks and assessment for determining student progress.
- Emphasizes creation of a Community of Learners in the classroom and in the school (p. 13).

According to Rhoades & McCabe (1992) a community
of learners is a group of people working together with a common goal of learning. There are four important elements in creating a community of learners:

- Using interactive, cooperative learning assignments and tasks.
- Viewing the classroom as a meeting.
- Teaching and learning specific social and human interaction skills such as successful communication processes, problem-solving and conflict management.
- Carefully integrating thinking skills development into daily curriculum (p. 17).

Members of the community of learners are:

- Responsible citizens
- Self-Confident
- Initiators
- Self-Monitoring
- Nurturing and concerned about others
- Future-oriented
- Thinkers
- Problem Solvers
- Able to function successfully as individuals and as team members (p. 17)

Feelings and classroom environment are an
important part of OBL and should be given a great deal of consideration when writing units (Rhoades & McCabe, 1992). In order for learning to take place, the learner must not feel stress or emotional strain (Terrell & Egasse, 1977). Students are excited about learning, enjoy coming to school and remember the things they are taught in a relaxed, trusting environment. They begin to develop positive feelings toward other students, for themselves, and for others as they learn, grow and prepare for their future (Rhoades & McCabe, 1992).

When planning a new unit, teachers need to keep in mind classroom environment, community of learners and how to establish a community of learners as well as the broad overall goals the teacher expects the students to know, be able to do, and to be like upon completion of the unit.
DEVELOPING A UNIT

The following unit planner is a thinking matrix which, instead of offering one correct way, offers a series of ideas which leads to the development of a unit which is meaningful to all students (Rhoades & McCabe, 1992).

The following are suggested steps when planning a thematic unit:

1. Establish a theme appropriate to class and grade level.
2. Select the desired outcomes you wish to emphasize.
3. Choose appropriate academic objectives.
4. Outline the culminating activity for the unit.
5. Select expanded opportunities for the unit.
6. Describe the authentic assessment to be used.
7. Design and list the lessons which will lead up to the culminating activity.
8. Evaluate the unit (Modified from Rhoades & McCabe, 1992, p. 18).

1. Establish a theme appropriate to class and grade level.

The section on the Science Framework for
California Public Schools gives suggestions for integrating science with other subjects. It also lists the six major themes as proposed by the Science Framework. It mentions that this is just one idea for organizing themes and that many other themes and methods for organizing those themes do exist.

2. Select the desired outcomes you wish to emphasize.

Outcomes are different from academic objectives in that outcomes are based upon the future and what we think students should know, do, and be like in order to be successful (Spady & Marshall, 1991 in Rhoades & McCabe, 1992). The following seven major outcomes have been defined by futurists and business leaders as the qualities needed for survival now and in the future:

- Responsible Citizen
- Global Citizen
- Collaborative Worker
- Quality Producer
- Effective Communicator
- Self-Directed Citizen

The following are criteria for exit outcomes:

1. Be clearly stated.

2. Represent a wide range of qualities.
3. Be limited to five or six items (behavioral indicators).

4. Directly relate to skills, attributes, and knowledge students will need for success in the world (Rhoades & McCabe, 1992, p. 33).

When planning a unit, one can choose from among the seven outcomes listed above. For each outcome their are behavioral indicators which can be chosen and help the teacher to focus in on the exact areas which would best help students prepare for their future. A list of behavioral indicators as adopted by Fontana Unified School District, Fontana, California is provided in Appendix ?. When choosing behavioral indicators it is best to limit it to a small number so the unit will be more manageable.

3. Choose appropriate academic objectives.

Academic objectives are the meat, academically speaking of what will be taught. These objectives for science can be found in the Science Framework as well as state core curriculum guides and district guides. Because units are taught thematically it would also be helpful to have copies of all the frameworks, ie: history-social science, language arts, mathematics etc. The elementary academic objectives for science can be
found in the section reviewing the Science Framework.

4. Outline the culminating activity for the unit.

The culminating unit activity should reflect all of the outcomes, behavioral indicators and academic objectives that have been taught and emphasized during the unit. Students should know in advance what is expected of them in the culminating activity. A rubric can be created by the teacher or with the students which will be the guide for what is expected. In the industrial method of teaching the culminating activity would probably be a test, in OBL the students know what is expected of them and are taught during the unit all that they will need in order to complete the activity.

5. Select expanded opportunities for the unit.

Expanded opportunities are where students are given numerous opportunities to be successful learners. When designing units, teachers need to think in advance of what they can do to provide more opportunities for students to learn and demonstrate that they are learning. Students do not all learn in the same way, and we need to build into our units a variety of learning activities to help the students be successful. The following are examples of expanded opportunities:

- Support personnel may be brought in to help at
anytime during the unit.
- Students may revisit items they would like to improve upon, and/or the teacher may choose to revisit outcome, objectives etc. in later units.
- Role playing.
- Time may be a variable and students can negotiate due dates for assignments, etc.
- Allow use of puppets or masks for students uncomfortable in presenting (Rhoades & McCabe, 1992, p. 163).
- Some students may need to be placed in a particular group for maximum learning to take place.
- Seating arrangements, and/or room arrangement may need to be modified.

6. Describe the authentic assessment to be used.

Assessment in OBL units should be an ongoing process and is actually built into the units at each culminating lesson activity and finally at the unit culminating activity. Because it is ongoing, expanded opportunities are provided when necessary, thus continuing to create a learning environment while at the same time continuing assessment. According to Rhoades and McCabe (1992), authentic assessment is a
"package" which should incorporate the following criteria:

- **Performance based** - Students are required to demonstrate learning of academic objectives in an activity directly linked to exit outcomes.
- **Multi-faceted** - Two or more assessment techniques are used.
- **Measured over time** - Multiple opportunities are offered students to revise and refine their efforts.
- **Criteria are clearly stated before beginning the assessment** - Students should clearly understand the standard of excellence before beginning the task.
- **More than one right answer** - The culminating activity is structured in an open-ended manner allowing students the opportunity to problem-solve and create their own solution.
- **Essential learning** - The assessment includes only items directly linked to exit outcomes and academic objectives (p. 55).

The following are a few examples of different types of authentic assessment:

- Written, oral, or physical responses to questions
related to the academic lesson or social skills.
- Teacher observation
- Student observers
- Rubrics
- Projects
- Portfolios
- Writings
- Audio tapes
- Video tapes
- Individual conferences
- Group conferences
- Presentations
- Charts, graphs, and other forms of visual aids
- Puppet shows
- Plays
- Written and oral exams
- Take home exams
- Group projects

7. Design and list the lessons which will lead up to the culminating activity.

When designing the actual unit lessons, it is important to remember the exit outcomes, behavioral indicators and specific academic objectives which were selected for the unit. The lesson culminating activity
should incorporate some of these specific items, but need not cover all of them. Only those which were directly taught and practiced in the lesson should be assessed in the culminating lesson activity. Some teachers have a tendency to try to do too many things and this does not lead to reaching the overall goals of the unit.

8. Evaluate the unit.

While students are working through the unit, and upon its completion, it is very helpful to keep notes of any changes that will improve the quality of the unit. Student input is also recommended in this section as it, along with teacher notes, will be beneficial in adjusting the unit for future use and in planning future units (Rhoades & McCabe, 1992, p. 106).

Appendix 1 includes a sample unit on measurement. Many of the ideas for the sample measurement unit were extracted from the Britannica Science System, K-6 program FOSS (Full Option Science System). FOSS, developed by Dr. Lawrence F. Lowery combines the content of science with the process of science to accomplish its two main goals: scientific literacy for all students and instructional efficiency for all teachers (Encyclopaedia Britannica Educational
Corporation, 1992). FOSS is in alignment with the Science Framework and is an excellent example of hands-on, investigative teaching which is easily comprehensible to the English language learner. For purposes of the sample unit, many ideas from FOSS have been adapted and/or changed to fit the criteria necessary for the Outcome-Based Learning model explained above, and also to incorporate strategies which facilitate English language learners' understanding.

Appendix 2 contains the blank forms for planning an OBL unit. These forms may be reprinted for ease in planning a unit.
APPENDIX 1
SAMPLE THEMATIC UNIT

The following unit was not written with the intent of limiting teachers and their teaching styles. Rather, it was written to give an example of an integrated, hands-on science unit which adheres to current literature on science instruction and instruction for the English Language Learner (ELL).

This sample unit contains ample opportunities for students to be involved in hands-on, investigative type activities, work together, share ideas and enjoy learning rich science and English language all in a stress free environment that is safe for those students whose primary language is not English.

When facilitating these science activities remember to make the language as comprehensible as possible to the ELL students by:

A. simplifying the input -
   * slower speech rate
   * focus on key vocabulary words
   * restate, redefine and repeat bilingually if necessary
   * shorter sentences
   * limit use of idiomatic expressions

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* enunciate clearly

B. provide context clues -
   * gesture
   * act out meanings

C. use realia whenever possible -
   * props
   * graphs
   * maps
   * multi-media
   * manipulatives
   * visuals

The main purposes of this unit are to provide examples of teaching hands-on science instruction in such a way that science is meaningful to the students, and to demonstrate opportunities within a science context for English language learning.
Unit Title: Measurement
Grade Level: 3-6

Exit Outcomes to be included in this unit:

1. Effective Communicator:
   - Can work with others on teams.
   - Claims own thought, ideas and feelings.

2. Inspired Learner:
   - Uses a variety of problem solving strategies.
   - Actively seeks new information.
   - Takes risks with ideas.

3. Productive Worker:
   - Is a cooperative team member.
   - Recognizes mistakes and corrects them.

4. Resourceful Thinker:
   - Understands that many problems do not have a single right answer.

Academic Objective to be included in unit:

1. Understands the necessity for a standard unit of measurement.

2. Develops an understanding and feel for the metric system.

3. Measures length and distance.


5. Weighs objects in grams.

7. Applies appropriate measuring skills in everyday situations.

8. Exercises language and math skills in the context of metric measurement.

9. Develops proper speaking skills while giving oral presentations.

Unit Culmination:

Activity: Making cookies from scratch. The ingredients will be pre-measured in standard units. The students, in groups of four, will need to re-measure the ingredients into metric units and bake according to recipe. When cookies are baked, the students will then use metric measurements to weigh the cookies, measure their temperature and their length. Upon completion, the students will create a poster showing all the ingredients and metric amounts required to bake the cookies. The poster and cookies will then be presented to the class.

Audience: Class, teacher, and principal.

Assessment: Unit rubric (see following page).

Expanded Opportunity Items:

1. Groups who need it will be given extra help from cross age tutors.
2. Revisit each type of measurement in the metric system.

Lesson Sequence:

1. The First Straw
2. Weight Watching
3. Take Me to Your Liter
4. The Third Degree
## Unit Culmination Rubric

**Measurement**

**Group Members:**

<table>
<thead>
<tr>
<th>Presentation Date:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Items</th>
<th>Group</th>
<th>Teacher</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group Work</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did your group work together?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All group members participated?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All group members said at least 3 encouraging words.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Poster</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colorful</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labeled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shows all ingredients and amount in metric measurement.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Presentation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All group members participated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spoke clearly.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explained how you converted the recipe.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared a cookie with each class member.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Answered audience questions.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One positive comment about the project.

________________________________________

Group member's initials. _____ _____ _____ _____
Lesson 1: The First Straw

Unit: Measurement

Culminating Lesson Activity: In partners, students will make their own meter tapes and measure a variety of objects in the room.

Outcomes: Can work with others on a team. Takes risks with ideas.

Academic Objectives: Students will understand the necessity for standard units of measurement and will measure length and distance using meters and centimeters.

Assessment Method: Teacher observation.

Students share their findings with the class.

Wrap-up: Each student responds with thumbs up, thumbs sideways or thumbs down to the following:

- I worked well with my team members.
- I feel comfortable trying new things.

Room Arrangement: Desks in groups of four.

Lessons to teach before this lesson: None

Steps in conducting this lesson:

- Find out what students know about measuring distance.

- Introduce straws as units.

- Students measure desks with straws (straws are
not equal lengths).
-Point out that their answers were different.
-Introduce standard units, meter and centimeter.
-Students become familiar with meter tapes.
-Measure straws.
-Describe paper meter tape they will make.
-Students make their own meter tapes and begin measuring objects in the room.
-Students will share their findings with their group and complete wrap-up.
-Read and discuss How Big Is A Foot?, by Rolf Myller.

Expanded Opportunity: for classes with ELL students as well as any other student who needs expanded opportunities and learns in different modalities.

TPR Extension -

Have everyone hold up their little finger and compare it to cm. Demonstrate first and then invite the students to physically measure objects in the room and compare their results with the other members in their group. (This activity helps the students to be physically involved and also allows more opportunities for students to converse together. It should be in a low stress environment where students are free to use
their primary language and are free to make mistakes in their second language).

Other Extension Activities for ESL students -

1. Demonstrate to the students how to measure their height. There are a variety of ways to do this. Students might be allowed to share their own ideas if they would like to. Once ideas and demonstrations are finished, assign each group of four to complete a height chart indicating each student's height. Upon completion, the charts are presented to the teacher in front of the rest of the class. At this time, the teacher records all the heights on a class chart. As a follow up, each quarter assign this same activity to the class. Both teacher and students will see growth in height as well as knowledge.

2. Have each student draw around their shoe on colored paper. They need to cut it out and have a friend measure how tall they are with their shoe print. Next, have the students measure each other with different shoe prints. Demonstrate on the board examples of how their data can be recorded so that each time they are measured they will know the results. Discussion questions can be: How many shoes tall are you? Are you the same number of shoes tall each time
you measured? Why or why not? Is everyone's shoe the same size? The measurements will vary and this will provide opportunity for small group and large group discussion.

Finally, the teacher may relate this back to lesson #1, The First Straw and our need for a standard unit of measurement. One child may be selected as the standard and all students can then use that standard shoeprint as their guide for measurement. (This is a good ESL activity because it will enable students to use their prior knowledge to complete the task, the teacher can demonstrate, thus making comprehension easy, and students will work together and verbally communicate as they complete the assignment).
Lesson 2: Weight Watching

Unit: Measurement

Culminating Lesson Activity: Students will each bring in a piece of fruit. In groups of four they will weigh the fruit, in grams, and add the fruit for a total weight. Finally, the class will make and eat a fruit salad.

Outcomes: Uses a variety of problem solving strategies. Is a cooperative team member.

Academic Objectives: Students will begin to weigh objects in grams. Students will exercise language and math skills in the context of metric measurement.

Assessment Method: Students will explain to the class how they arrived at their answers.

Teacher observation.

Room Arrangement: Desks in groups of four.

Lessons to teach before this lesson: None

Steps in conducting this lesson.

Day 1:

- Introduce weight.
- Hold up three objects and tell students they are going to place similar objects in order of lightest to heaviest.
-Introduce balance.
-Use balance to verify that they placed the objects in correct order by weight.
-Introduce units.
-Explain weighing in paper clips.
-Weigh objects using paper clips.
-Discuss why groups arrived at different answers.
-Introduce need for a standard unit of measurement.
-Introduce grams.
-Weigh objects in grams.
-Clean up.

Day 2:
-Read and discuss Weighing and Balancing, by J. Srivasta.
-Review weighing and the balance.
-Weigh fruit, working in groups.
-Add up the total.
-With parent volunteers, make fruit salad and eat.

Expanded Opportunities: Continued practice with weighing in cooperative groups and small groups with teacher.

Other extensions for classes with ESL Students -
1. In groups of four, students will estimate the
weight of a quantity of unpopped popcorn. A recorder will record this estimate along with other estimates and results. The students will weigh the popcorn, record results and then pop the corn.

Before eating, the students again will estimate the weight of the now popped popcorn. Have them record estimates and then weigh the corn for verification.

Involve the students in a whole class discussion to talk about their results and why the popped corn weighed less than the unpopped corn.

Allow the group with the closest estimates to pass out the popcorn to the class so they can eat their science lesson. (This type of lesson is good for ESL students because they are using prior knowledge to help them with English language comprehension).

2. Give each group 75 one gram blocks. Ask them to divide the blocks into three equal groups. (If needed for comprehension, give a brief demonstration of what is expected). Ask each group to construct three differently shaped buildings with their blocks. One to have the appearance of a large building, a medium sized building and a small building.

Ask them to decide as a group which building weighs the most down to the least. A recorder should
record their results. Then have the students weigh each building to verify their results. Have them discuss their answers as a group first, and then open the discussion up to the entire class. Even with a balance, some students may still not agree. The students could then be invited to reconstruct each building so that the blocks are all in a straight row. Then ask them which one weighs the most. The expected answers at this point are that the buildings are all the same weight. (This works really well with ESL students because it is hands-on, it involves the students' prior knowledge, it is a physical TPR activity and the students are forced to speak together in their groups. All of this hopefully is in an environment which does not criticize when mistakes are made).

3. Provide a small variety of liquids for the students to weigh. Demonstrate how they are to measure beforehand. Then place these liquids into a freezer for the following day. On day 2, remove the now frozen samples and have the students estimate their weight. Then they will weigh each sample, record their results and discuss these results. Water and something carbonated would be two good liquids to include.
(While discussing the investigation, if students need to have something repeated in their primary language, the teacher may do so. If the teacher does not speak the primary language maybe another student can assist).
Lesson 3: Take Me To Your Liter

Unit: Measurement

Culminating Lesson Activity: Students will bring containers from home. They will determine their capacities (in liters and milliliters) and label them. Students will then line up the containers by capacity. Then line them up according to other properties.

Outcomes: Understands that many problems do not have a single right answer. Actively seeks new information.

Academic Objectives: Students will measure liquid volumes and capacities. Applies appropriate measuring skills in everyday situations.

Assessment Method: Rubric (See Rubric Lesson #3).

Room Arrangement: In groups of four for measuring capacities, then at back table for lining up containers.

Lessons to teach before this lesson: None

Steps in conducting this lesson:

Day 1:
- Tell students that you want them to help you measure the capacity of a cup. (Describe
capacity)
- Tell them the unit of measurement will be a vial. (The vials should vary in size without students becoming aware.)
- Distribute materials.
- Students measure capacity of cups.
- Compare their results.
- Introduce standard, liter and milliliter.
- Introduce 100 ml beaker.
- In ml have students measure capacity of cup.

Day 2:
- Introduce volume.
- Introduce syringe and graduated cylinder.
- Provide opportunities to practice measuring volume and record answers.

Day 3:
- Culminating activity, as described earlier.

Expanded Opportunities: Continued practice, cross age tutoring and small group tutoring with teacher.

TPR Extensions For Classes With ESL Students -

In this lesson, students will need to follow a recipe for making lemonade. Demonstrate to the students each step in the recipe and write the recipe on cards for each group. (Pictures would be helpful
for comprehension). Put 100 ml of hand squeezed lemon juice into a 1000 ml beaker. Add a 5 to 1 ratio of water (500 ml), and finally 100 ml of sugar.

Invite the students in groups of four to begin hand squeezing their lemons and then continue to follow the recipe. Stress that no one is to drink their lemonade until instructed to do so. Have a member from each group bring their 1000 ml beaker with lemonade to the front of the room and line them up in a row. Allow the students to visually compare if all the levels of lemonade mixtures are equal. Discuss why or why not.

Distribute a small cup to each student so that he/she can sample lemonade from each beaker. Again discuss any differences and why. To conclude this activity ask each student how they might do their lemonade differently the next time. Accept each answer. For example, some might have been really sweet for whatever reason and they liked it sweet. Maybe their mixture was accidentally a 4 to 1 ratio. (This is a great activity for ELL students because their success is not dependent upon language. The teacher has modeled for the class, an outline was given, the recipe was on recipe cards to reinforce the English, the students are interested and have the opportunity to

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verbally share together in a stress free environment).  
2. In preparation for the culminating activity and to involve more practice as well as provide more language the students can make pudding. The teacher should demonstrate first how the pudding is to be made. The recipe cards should then be given out and the students allowed to make 1 batch of pudding in each group. Add 474 ml milk (2 cups) to 1 box of pudding in a 1000 ml beaker. Beat the pudding with a spoon until thick. The recorder needs to record the volume of pudding in the beaker. Again in this activity the beakers can be lined up in a row so that all students can visually compare the levels of pudding. There should be no visible differences. If differences are evident, the teacher may use this as an opportunity for class or small group discussion.
Lesson # 3 Rubric.
Capacity

Group Members: ____________________
________________________

<table>
<thead>
<tr>
<th></th>
<th>GROUP</th>
<th>TEACHER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group Work</strong></td>
<td>YES/NO</td>
<td>YES/NO</td>
</tr>
<tr>
<td>Did your group work together?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All group members participated?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did all group members agree?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| **Content**                 |       |         |
| Did your group bring containers from home? |     |         |
| Did your group determine the capacity of each container? |     |         |
| Are all of the containers labeled? |       |         |

What was the easiest thing about this assignment?

Teacher Comments:

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Lesson 4: The Third Degree

Unit: Measurement

Culminating Lesson Activity: In partners, or alone, students will check out thermometers for a take-home investigation. They will measure such things as hot tap water, refrigerator temperature, freezer temperature etc. Their answers will be recorded and shared with the rest of the class the following day.

Outcomes: Claims own thoughts, ideas and feelings. Recognizes mistakes and corrects them.

Academic Objectives: Students will measure temperature of liquids and air. Students will develop proper speaking skills while giving oral presentations.

Assessment Method: Record sheet to be completed by each individual or partnership.

Wrap-up: An individual written response to the question "One thing I learned about measuring temperatures is..."

Room Arrangement: Desks in groups of four to be used as centers for measuring.

Lessons to teach before this lesson: None

Steps in conducting this lesson:

- Discuss vocabulary. Hot, cold, where is it hot?
-Introduce temperature.
-Describe investigation: Students will rank cups of water in order from warmest to coldest. May only use one finger on his or her right hand. Start with cup A, then B, then C, no going back. Each person can use one finger on their left hand to double-check. (A and C are the same, students will not know this).
-Distribute water.
-Report results.
-Introduce thermometer.
-Use thermometers to verify student answers.
-Discuss the results.

Day 2:
-Continue measuring with thermometers.
-Measure hot water, cold water and then mixture.
-Record and discuss results.
-Students may then measure other things in room or outside, with supervision.

Assign culminating activity for homework. (Check out thermometers)

Expanded Opportunities: Continued practice with cross-age tutors.
Extension Activities for classes with ESL Students -
1. In their cooperative groups have students measure
the temperature of three parts of the room; high,
medium and low. Have the recorders record their
findings. Then at 1/2 hour intervals during the day
have each group measure the temperature in the same
three places. (Be sure to not run the heater or the
air conditioner this day). As the investigation
continues and the findings are recorded the results
should be discussed. Are the temperatures the same?
Why or why not? (This lesson is helpful to ESL
students because it involves their prior knowledge.
They are physically doing something, recording results,
and are again given opportunities to discuss with their
friends in a stress free environment. If additional
help is needed in their primary language, help them if
possible or allow other students to translate).
2. This lesson is a take off from the previous lesson
in that the students will be recording temperatures
three times during the day. Again they will physically
be involved, they will be using prior knowledge and
will have opportunities for discussion. The teacher
needs to demonstrate how to take a body temperature,
how to read the thermometer (if needed), and finally
how to sterilize the thermometer when finished. When the students understand this process and a few can effectively demonstrate to the class, have each student take his/her own body temperature three times throughout the day. First thing in the morning, around lunch time, and again in the afternoon before they leave. They must record their answers and again discuss their findings.
Culminating Activity: Making Cookies

Unit: Measurement

Activity: The students will be making cookies from scratch by re-measuring ingredients from standard units to metric units. Upon completion, the students, in groups, will weigh their cookies, measure their length, and measure their temperature. In their groups of four, the students will then make a poster demonstrating the ingredients used and the amount in metric measurement. The poster and cookies will then be presented to the class.
ENGLISH / SPANISH SCIENCE VOCABULARY

FOR SAMPLE UNIT

(NOTE: This sample unit was written specifically for a school district where the majority of LEP students' primary language is Spanish. For this reason the vocabulary list provided below is in English and Spanish).

Arm span ........ ..• Brazos Extendidos
Balance .............. ...... Balanza
Balance Beam ............... Astil de la Balanza
Beaker ............... Cubeta
Blocks ............... Cubos
Capacity ............... Capacidad
Centimeter (cm) ............... Centimetro
Cold ................ Frio
Container ............... Recipiente
Degree Celsius ............... Grados Celsio
Distance ............... Distancia
Estimate ............... Estimar
Estimated Capacity ............... Capacidad Estimada
Estimated Weight ............... Peso Estimado
Estimated Length ............... Longitud Estimada
Fulcrum ............... Fulcro
Graduated Cylinder ........ Cilindro Ajustado
Gram (g) ......................... Gramo
Height ............................. Altura
Hot ................................. Caliente
How Heavy Is It? ............... Que Pesado Es?
How Long Is It? .................. Que Largo Es?
Kilogram (kg) ..................... Kilogramo
Kilometer (km) .................... Kilometro
Label ............................... Etiqueta
Lemon .............................. Limon
Lemonade ......................... Limonada
Length .............................. Longitud
Liquid .............................. Liquido
Liter (l) ............................ Litro
Measured Weight ................. Peso Medido
Measured Capacity ............... Capacidad Medida
Measured Length ................. Longitud Medida
Measurement ...................... Medida
Measuring Temperature ......... Temperatura Medida
Meter ............................... Metro
Metric .............................. Metrico
Milliliter (ml) .................... Mililitro
Millimeter (mm) .................. Milimetro
Object .............................. Objecto
Popcorn . . . . . . . . . . . . . . Palomitas de Maiz
Results . . . . . . . . . . . . . . . . Resultados
Standard . . . . . . . . . . . . . . . . Peso Comun
Syringe . . . . . . . . . . . . . . . . Jeringa
Temperature . . . . . . . . . . . . . . Temperatura
Thermometer . . . . . . . . . . . . . . Termometro
Vial . . . . . . . . . . . . . . . . . . Frasquito
Volume . . . . . . . . . . . . . . . . . . Volumen
Weights . . . . . . . . . . . . . . . . . . Peso
APPENDIX 2

UNIT ORGANIZER FORMS

Unit Title: ________________________________________________

Grade Level: ____________________________________________

Exit Outcomes to be included in this unit: _________________

________________________________________________________________
________________________________________________________________
________________________________________________________________

Academic Objectives: ______________________________________

________________________________________________________________
________________________________________________________________

Unit Culmination Activity: _________________________________

________________________________________________________________
________________________________________________________________

Audience: ________________________________________________
Assessment: ________________________________

____________________________

____________________________

Expanded Opportunity Items: __________________________

____________________________

Lesson Sequence:

Lesson 1: ____________________________

Lesson 2: ____________________________

Lesson 3: ____________________________

Lesson 4: ____________________________

Lesson 5: ____________________________

Lesson 6: ____________________________
Expanded Opportunities: ____________________________

Steps in conducting this lesson: __________________________

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________________________________
EVALUATION OF UNIT

Outcomes to change before repeating unit: __________

________________________________________________________________________

Academic objectives to change before repeating unit: __________

________________________________________________________________________

Changes in assessment methods: __________

________________________________________________________________________

Changes in lesson plan: __________

________________________________________________________________________

Changes in culminating activity: __________

________________________________________________________________________

Changes in expanded opportunities: __________

________________________________________________________________________

Comments: __________

________________________________________________________________________

APPENDIX 3

BEHAVIORAL INDICATORS LINKED TO EXIT OUTCOMES

#1 EFFECTIVE COMMUNICATORS

- Gets the listener's attention before speaking
- Looks at listener
- Claims own thoughts, ideas and feelings
- Is Clear - stick to one topic at a time
- Checks with listener to be sure message is clear
- Uses pronouns sparingly and correctly to avoid confusion
- Elaborates on the message if listener says she doesn't understand
- Uses visual cues to communicate message when appropriate
- Speaks concisely - communicates the main point of the message without excess and superfluous comments
- Is complete - makes sure all important details of the message are included
- Identifies feelings by name
- Uses appropriate nonverbal communication to send messages
- Nonverbal and verbal messages are congruent
- Provides verbal and nonverbal feedback
- Uses "I-Messages" in conflict or potential conflict situations
- Looks at the speaker
- Clarifies by asking questions
- Checks perceptions of speaker's feelings
- Listens to the whole person - verbal & nonverbal messages
- Sets aside own point of view when listening to make sure he understands speaker's meaning and intent
- Has developed strategies to communicate with others with different cognitive/learning styles
- Has developed strategies to communicate with other racial and ethnic groups
- Can teach others, is able to explain ideas and concepts that are new to the listener
- Can negotiate in a non-confrontive manner
- Can work with others on teams
- Can express precise and accurate information in writing
- Can clearly state her own point of view in a
written message
-Can communicate in writing to a variety of audiences and for different purposes
-Can demonstrate the four domains of writing
-Is able to use a word processing program
-Is able to use computer search programs
-Is able to use modems and FAX machines
-Can communicate effectively on the telephone
-Understands the effect of nonverbal messages when speaking on home, e.g., smile carries through, so does frown

#2 INSPIRED LEARNERS

-Actively participates in decision making
-Participates in long and short range planning
-Participates in strategic planning
-Uses the computer as a learning tool
-Uses a variety of problem solving strategies
-Is able to select an efficient problem-solving strategy to match the situation
-Makes life choices that ensure a healthy mind and body
-Actively seeks new information
-Has obtained a basic competence in reading, writing, listening, speaking and technological skills
-Has developed own criteria for assessing growth of own thinking and learning
-Takes risks with ideas
-Defines and pursues personal excellence
-Is aware of own learning style
-Is able to design and (advance) organizer for both school and personal life
-Has developed a wide range of learning strategies
-Initiates study in areas of interest and in areas where more knowledge is needed
-Takes responsibility for own learning
-Demonstrates enthusiasm for learning and discussion differing points of view, different interpretations of content
-Demonstrates desire to continue learning after leaving school
-Recognizes that people learn from each other regardless of differences in age, ethnicity, gender, religion, etc.
-Places no limits on ability to learn
-Encourages others in and out of class

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The document provides a list of skills and attributes that a productive worker should possess. These include:

- Helps others learn
- Is a cooperative learning team member

#3 PRODUCTIVE WORKER

- Is punctual - arrives on time to meetings and personal appointments
- Balances work and personal life
- Participates in short and long-term planning
- Approaches change with a positive attitude
- Completes school and personal tasks in a timely manner
- Is able to turn conflicts into problems to be resolved
- Knows various problem solving strategies and selects appropriate strategy for any given situation
- Is able to manage data on a computer
- Is able to organize and plan time
- Is able to schedule assigned tasks
- Is responsible
- Recognizes mistakes and corrects them
- Interacts positively with co-workers, supervisors, subordinates, and consumers
- Is sociable
- Is a self-manager
- Has a clear self definition of integrity
- Perseveres when presented with a difficult problem
- Treats others with respect
- Prioritizes tasks and activities according to life values
- Schedules priorities
- Establishes goals and objectives and designs action plan to accomplish
- Continues learning
- Is a cooperative team member
- Uses work skills to contribute to the community
- Helps others learn the job
- Participates in decision making
- Participates in short and long term planning
- Takes pride in her work
- Approaches change with a positive attitude
- Can adapt to new situations

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- Understands cultural diversity, ideas and practices
- Can participate in a culturally diverse social milieu
- Recognizes the socio-economic diversity present in the world today
- Can understand and speak more than one language fluently
- Recognizes own values
- Makes rational decisions based on own values
- Recognizes that he has a world view not universally shared
- Is aware of prevailing world conditions and developments
- Is aware of global change
- Understands that human beings have choices and the range of choices may be linked to socio-economic conditions
- Is open to differing perspectives
- Understands the relationship of systems such as air, land and water to world balance
- Understands that a variety of religions are practiced in the world and can discuss the major components of those that have the greatest impact on his culture
- Understands the impact of disease on populations throughout the world
- Is aware of the relationship/impact of music to culture
- Is aware of the relationship of sports to culture
- Generates a sense of community with a selected population
- Views self in control of own destiny
- Understands ecological issues of concern in the world and takes steps to improve the situation
- Understands the interconnectedness of nations
- Participates in any way possible to achieve and maintain peace in the world
- Respects other cultures
- Recognizes own importance in the world
- Uses skills to contribute to the community
- Understands the interconnectedness of ecological, economic and technological spheres
- Is neither ethnocentric nor ethnohostile, recognizes value of own nation and others
- Nurtures own spiritual sphere
#5 RESOURCEFUL THINKER

- Understands that many problems do not have a single right answer
- Is able to select essential facts from a field of information and apply to current situation
- Is able to participate in non-judgmental brainstorming
- Recognizes own cognitive style
- Can learn new behaviors by observing others
- Considers consequences of own actions
- Seeks activities that challenge the intellect and imagination
- Is able to transfer new learning outside the learning environment
- Is able to link two or more sets of information and perceive a relationship
- Is involved in metacognition
- Is aware of own types of intelligence
- Is able to organize thinking
- Is able to organize data using a variety of techniques
- Possess a variety of thinking strategies
- Can select and analyze data
- Can compare and contrast
- Can manage personal resources
- Can see things in the "mind's" eye
- Seeks new ideas
- Seeks new ideas
- Considers other's points of view
- Is a self-initiator
- Will try new ways of doing things
- Feels comfortable with uncertainty
- Understand written, oral and nonverbal messages
- Can follow written and oral directions
- Turns "failure" into a learning opportunity
- Waits before he acts
- Establishes goals then develops a strategic plan to accomplish the goals
- Studies the thought processes of others
- Demonstrates curiosity

APPENDIX 4

SCIENCE RELATED LITERATURE
<table>
<thead>
<tr>
<th>TITLE</th>
<th>AUTHOR</th>
<th>PUBLISHER</th>
<th>DATE</th>
<th>GRADE</th>
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<tbody>
<tr>
<td>Machines at Work</td>
<td>Barton, B.</td>
<td>Crowell</td>
<td>1987</td>
<td>K-3</td>
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<tr>
<td>Opt: An Illusionary Tale</td>
<td>Baum, A.</td>
<td>Viking</td>
<td>1987</td>
<td>3-6</td>
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<tr>
<td>Gravity is a Mystery</td>
<td>Branley, G.</td>
<td>Harper</td>
<td>1986</td>
<td>3-6</td>
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APPENDIX 5

QUESTIONNAIRE - EVALUATION OF PROJECT

After reading the project, please comment on the following areas:

1. Simplicity of the project: ________________________
   ________________________
   ________________________
   ________________________

2. Usefulness of the project in your science program:
   ________________________
   ________________________
   ________________________

3. Usefulness of the project in working with Limited-English proficient students: ________________________
   ________________________
   ________________________

4. How helpful is it to have a synopsis of the Science Framework for California Public Schools? ________________________
   ________________________
   ________________________

5. Is it helpful to teach science in a thematic way as suggested? What are some of your successes with this area? ________________________
   ________________________
   ________________________
6. What new cooperative learning activities have you tried as a result of this project? 

7. What information were you able to use from the unit organizer section? 

8. Would you continue to use the organizer next year? 

9. Is the information easy to understand and does it have application to your program? 

10. Suggestions for improving the project: 

11. How has this project changed how you teach science to your Limited-English proficient students? 

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12. Has the way you teach science to your English only students changed? How? ___________________________
REFERENCES FOR HANDBOOK

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