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How we can help English language learners learn science standards while meeting the English language development standards for the Ontario-Montclair School District

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HOW WE CAN HELP ENGLISH LANGUAGE LEARNERS LEARN SCIENCE STANDARDS WHILE MEETING THE ENGLISH LANGUAGE DEVELOPMENT STANDARDS FOR THE ONTARIO-MONTCLAIR SCHOOL DISTRICT

A Project

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by

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ABSTRACT

This is a project that takes into consideration inquiry based science, English language development standards, the National Science Education Standards, the California State Science Content Standards, and the Ontario-Montclair third grade science standards. The unit addresses the needs of English Language Learners through the context of science. A plant unit was developed that is both standards based, from the national level down to the district level, with English Language Development standards interwoven. Included is a discussion on how people learn, effective science instruction, and strategies to support learning English in the classroom.

Constructivism guides the discussion of how people learn. Effective science instruction includes a discussion on establishing goals for the learner, the lesson plan format, along with a discussion on inquiry. Finally, the discussion on strategies to support learning English in the classroom includes a discussion on literature logs, reflections, group work, and class discussions.

From the review, a unit was developed that incorporates many of the key findings of how people learn,

effective science instruction, and strategies for learning English in the classroom. The unit is a science unit on plant survival.

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CHAPTER ONE

INTRODUCTION

Introduction to the Project

This project will look at several aspects of English Language Development in relation to learning science standards. The project will explore English Language Development (ELD) strategies, such as Sheltered English and Specially Designed Academic Instruction in English, and best practices for science instruction that is based on the research of how people generally learn concepts.

In addition to looking at these different topics, a standard will be found in the National Science Education Standards, California State Science Standards, and Ontario Montclair School District Standards. In addition to these standards, the *Atlas of Science Literacy* will be used to better understand what information a student should know prior to the unit of study, and what the student will learn in the future that builds on the particular unit of study.

Purpose of the Project

As teachers, we are required to spend so many minutes a day teaching specific subject areas. In the Ontario-Montclair School District, it is required that teachers teach three hours of scripted language arts, thirty minutes daily of English Language Development (ELD), and sixty-ninety minutes of math daily. The school day is six hours and thirty-five minutes on most days. Lunch consumes fifty minutes and there is fifteen minutes for a morning recess in third grade. That leaves five and a half hours to teach language arts, ELD, and math. There is little or no time for science or social studies. It is my desire to develop a unit that demonstrates that ELD and science can be integrated and that students will still succeed in both areas.

Significance of the Project

If a unit can be designed that incorporates both English Language Standards, as well as science standards, perhaps then teachers can be given the freedom to teach science during the designated ELD time and give students more opportunities to experience science in their classrooms.

A science unit will be developed using the National Science Education Standards, California State Science Content Standards, and the Ontario-Montclair School District standards for third grade science. In addition to the science standards, the Ontario Montclair School District's English Language Development standards will be included for each level of language proficiency. In addition to the standards, the unit will include goals and objectives, background information, rubrics, and activities. The activities will be standards based (according to standards needed to be addressed) as well as utilize findings from research to incorporate what is best for students who speak a different language.

Limitations of the Project

The limitations of the project are that although the state standards and national standards are examined, the focus will be on the standards for the OMSD district, as well as the OMSD standards for English language development. In addition, the requirements for ELD may vary by district and their population need.

Definition of Key Terms and Abbreviations

ELD-English Language development

FEP-Fluent English proficient

Inquiry-"refers to the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (National Science Education Standards, 1996, p.23).

LEP-Limited English proficient

OMSD-Ontario Montclair School District

SDAIE-Specially Designed Academic Instruction in English- "…instructional process that includes teaching content and English language development simultaneously, offers an opportunity to develop effective and innovative practices to incorporate English Language Learners…" (Cline and Necochea, 2003, p.18).

Sheltered English-an approach to teaching that "help Limited English Proficient and Fluent English Proficient students through the difficult task of learning academic content while mastering a second language" (Watson, Northcutt, and Rydell, 1989, p.59).

CHAPTER TWO

LITERATURE REVIEW

This chapter will review literature that surrounds how people learn, effective science instruction, and support for learning English using science and science concepts. In addition to gaining a better understanding of these different areas, how these can be used as strategies in teaching science is discussed.

How People Learn

People learn in many different ways. Some people learn by association and some people learn best by employing their learning styles. There have been many different philosophies of how people learn. A widely accepted approach to science instruction is constructivism. Some researchers believe that students learn when the prior knowledge of that student is accessed. One of the easiest ways to access a student's knowledge is to begin with a story. Collins references great teachers such as Socrates and Aristotle. Stories help students to understand a concept in a new way. "One of the ways Socrates taught was by using stories. Stories allowed his students to see familiar items, events, and phenomena in new ways" (Collins, 2002, p.5). When Socrates would finish with the story, he would then ask his students questions. The type of questioning employed would require the students to think about a concept in depth and to see possible connections. "These stories were followed by what today we might call divergent and probing questions. From the stories and questions, students began to develop knowledge by relying on what they already knew-their prior knowledge" (Collins, 2002, p.5).

Another great philosopher and teacher, Aristotle, believed that students learned based on the connections that students made between different concepts. "He believed that all mental life could be explained in terms of two basic components: elements (ideas) and the associations (links) between them" (Collins, 2002, p.6).

In Collins' article, she begins discussing "Contemporary Learning Theories." These new theories have roots in ideas from Socrates and Aristotle. New learning theories stress the importance of student engagement in an activity. "…learning requires activity on the part of the learner-that something is happening in the mind and that it is possible to infer what that is from the actions of the person engaged in learning" (Collins, 2002, p.8).

Collins further cites early cognitive scientists such as John Dewey and Jean Piaget. These scientists believed that when students were engaged in an activity, it helped them to make connections between different ideas. All of these ideas helped to create the learning theory of constructivism. A student needs to make connections between concepts.

> …there are some recognized features of constructivism: learning is active; learning is the interaction of ideas and processes; new knowledge is built on prior knowledge; learning is enhanced when situated in contexts that students find familiar and meaningful; complex problems that have multiple solutions enhance learning; and learning is augmented when students engage in discussions of the ideas and processes involved.
> (Collins, 2002, p.9)

Learning does not end when a student leaves a classroom. It is a lifelong process. It has been previously established that it is active. "Constructing knowledge is a lifelong, effortful process requiring significant mental engagement from the learner" (Mestre and Cocking, 2002, p.15). While a student is learning, the learner is actively trying to assimilate new information.

Constructivism is a way that people make sense out of what is going on around them. The basic ideas of constructivism in the classroom are that

> Learning results from exploration and discovery…Learning is a community activity facilitated by shared inquiry…Learning occurs during the constructivist process…Learning results from participation in authentic activities…Outcomes of constructivist activities are unique and varied. (Alesandrini and Larson, 2002, p.118-119).

Students learn through discovery. As students are exploring a concept, they are applying this new information to what they already know. If it doesn't fit with what the learner already knows, then the learner begins to construct new meaning from the experiences. Alesandrini and Larson state, "Constructivists see learning as a process of actively exploring new information and constructing meaning from the new information by linking it to previous knowledge and experience" (118).

The role of the teacher in a constructivist classroom is very different from the traditional role of teachers. Teachers act as guides in a constructivist classroom. They help students by asking questions and somewhat directing them to the path that the students could pursue to solve the problem. They do not do the thinking or the work for the students, instead "…teachers in a constructivist classroom are called to function as facilitators who coach learners as they blaze their own paths toward personally meaningful goals" (Alesandrini and Larson, 2002, p.118).

In a constructivist classroom, learning occurs through the interaction of group members. Through reflections and discussions with group members, learners are able to see different ways of looking at a problem. This can help a learner to approach a problem in a different way. Alesandrini and Larson suggest that

> Constructivism favors collaborative work groups that actually work together interacting to accomplish shared goals…Group members constantly 'negotiate meaning' during the constructivist activity to adjust to the developing solutions of the problem. (Alesandrini and Larson, 2002, p.119)

Constructivist beliefs include the idea that what learners are learning should have something to do with what they may encounter in real life. Oftentimes, students learn concepts that seem disconnected to anything that a student may encounter. When this happens, students are unable to make a connection and may become less engaged in the activity (Alesandrini and Larson, 2002).

Alesandrini and Larson (2002) also give key ideas on how to create a constructivist classroom. A teacher needs to have a deep conceptual knowledge of what it is that he or she will be teaching and then,

> They begin by setting objectives and creating a scoring rubric that both they and the students may use to assess the final products. They then plan the activity, create a model, and reflect

upon their respective projects. Finally, they try out the activity with their own students. (121)

The goal for learning is to achieve understanding of a concept. Understanding is more than just knowing. Knowing is being able to do something whereas understanding is being able to explain something and apply it. While teachers want students to know concepts, only knowing a concept doesn't provide support to the student when asked to apply it in a new way. The understanding of a concept allows the student to apply the learning to new situations. Teaching for understanding strives to accomplish this goal (Perkins and Blythe, 1994).

Perkins and Blythe (1994) believe that the only way to learn for understanding is to engage in it and do it thoughtfully. They compare it to learning to skate, "How do you learn to roller skate? Certainly not just by reading instructions and watching others, although these may help. Most certainly, you learn by skating. And if you are a good learner, by thoughtful skating…" (6). A learner must be immersed in activities that require them to "generalize, find new examples, carryout applications, and work through other understanding performances. "And they must do these things in a thoughtful way, with appropriate feedback to help them to perform better" (6).

Teaching for understanding involves four parts. It includes generative topics, understanding goals, understanding performances, and ongoing assessment. Generative topics are topics that are "big ideas" in the content area. In addition to being a big idea, it is a topic that students can relate to. Finally, it has to be able to relate to other topics. Generative topics help the student to connect to the concept being learned and help them to see how it relates to other subject matter. Students are not learning isolated facts but concepts and how they are related to one another. "In general, we look for three features in a generative topic: centrality to the discipline, accessibility to the students, and connectability to diverse topics inside and outside the discipline" (Perkins and Blythe, 1994, p.6).

The understanding goals found in the teaching for understanding framework are familiar to teachers. They are what the students will be able to do as a result of the activities. It helps to identify what these goals may be prior to beginning a topic because it provides focus for the teacher and students. "To create focus, teachers have found it useful to identify a few specific understanding goals for a topic… 'Students will understand that…' or 'Students will appreciate that…'" (Perkins and Blythe, 1994, p.7).

Understanding performances are what students are doing that helps them to understand a concept. These activities are carried out throughout the entire process. "Students should be engaged in performance that demonstrates understanding from the beginning to the end of the unit or course" (Perkins and Blythe, 1994, p.7).

Finally, teaching for understanding incorporates ongoing assessments. According to Perkins and Blythe (1994), this ongoing assessment provides "criteria, feedback, and opportunities for reflection" (7). Ongoing assessments provide opportunities for teachers to identify whether or not their students understand the concept and what changes need to be made to help the students better attain the concept before they reach the end of the unit.

Teaching for understanding takes time. Students need to have adequate time to explore a concept in different ways to help to build their understanding of a concept. Unger suggests "giving students more time invites them to get involved in the kind of thinking that will foster the building of their own understanding" (Unger, 1994, p.10).

In the book, *How People Learn: Bridging Research and Practice*, a committee set out to gain an understanding of the research on learning and teaching. The committee found several key findings with regard to student learning. Among the research explored, support was found that students come into the classroom with "preconceptions" and the student needs to take responsibility for his or her own learning through a "metacognitive" approach to learning.

Students do not come to a class as a blank slate. They bring with them their experiences and prior knowledge to help explain the way the world around them works. Their ideas need to be brought to the surface and engaged in order for the student to be able to learn a new concept. If a student is not engaged, it is less likely that the student will change his or her belief systems to accommodate what the teacher is trying to teach.

> Students come to the classroom with preconceptions about how the world works. If their initial understanding is not engaged, they

> may fail to grasp the new concepts and information that are taught…(Donovan et al., 1999, p.10)

Furthermore, a student must be responsible for his own learning. A student can achieve this by becoming more metacognitive. A teacher can instruct a student on how to create goals that the student would like to achieve during a lesson, unit, or trimester. Students need to be instructed on how to monitor their progress and how to evaluate their own learning. "A 'metacognitive' approach to instruction can help students learn to take control of their own learning by defining learning goals and monitoring their progress in achieving them" (Donovan et al., 1999, p.13).

This being said, there are important implications that teachers can take away from the committee's findings. If a teacher knows that a student comes to a class with preconceptions about the world and how it works, then the teacher needs to identify what those preconceptions are so that lessons can be developed that addresses those preconceptions.

> …the teacher must actively inquire into students' thinking, creating classroom tasks and

> conditions under which student thinking can be revealed. Students' initial conceptions then provide the foundation on which the more formal understanding of the subject matter is built. (Donovan et al., 1999, p.15)

In addition to "actively" seeking out what students are thinking, formative assessments can be utilized in order that the students' thinking becomes clear to everyone involved. "The use of frequent formative assessment helps make students' thinking visible to themselves, their peers, and their teacher" (Donovan et al., 1999, p.15).

Effective Science Instruction and Classroom Implications

The previous discussion stressed the importance of engagement in student learning. Students need to be active in the process of learning. The following discussion illustrates the components of effective science instruction. It will highlight what teachers need to do as well as what the curriculum should embody.

Students enter the science classroom with preconceived notions of how the world works. From an early age, students encounter different phenomena. The explanations that the students initially develop become the basis for their understanding of a phenomenon (Bybee, 2002, p.28).

In order to effectively teach a science concept, a teacher needs to determine the beliefs of his or her students. Once a teacher determines the students' preconceptions, opportunities need to be developed that create challenges to the students' preconceptions. Once the preconceptions are challenged, the students will then need to reformulate these conceptions. According to Bybee,

> …new concepts develop from challenges to current conceptions which may take the form of social interactions, encounters with new and different phenomena, personal reflection, specific questions from peers and parents, activities that are part of the science curriculum, and interactions with science teachers. (Bybee, 2002,p.28)

Once a student's ideas are challenged, a teacher then can introduce concepts that would make sense to the student and would help to explain the concept in the correct way. Students would then be given opportunities to explore the ideas in a context that makes sense to the student.

> …approaches designed to identify students' current conceptions, challenge the adequacy of current explanations; introduce scientific concepts that are intelligible, plausible and helpful; and provide opportunities to apply new ideas in a familiar concept. (Bybee, 2002, p.28)

Problem solving for adults follows a certain pattern. Something usually grabs the persons' curiosity and the person begins to ask questions. After the questions are asked, a person tries to solve the problem or answer the questions. A person can then try to use this solution in a different situation. Bybee says,

> the more formal problem solving of adults often follows a pattern of initial engagement, exploration of alternatives, formation of an explanation, use of the explanation, and evaluation of the explanation based on the efficacy and responses from others. (31)

For children, this turns into activities that are designed to engage the students; giving them opportunities to explore, explain, extend, and evaluate what they are learning (Bybee, 2002).

Activities that contain the components of engagement, exploration, explanation, extension and evaluation alone are not enough to ensure that a student has adequately learned a particular concept. Individual activities do not give students enough to learn concepts. In addition to activities that contain these components, multiple connections are required for a student to learn. Teachers are well aware that even though they explain a concept to students, some students will not understand. These students are more likely to learn a concept when they are given numerous opportunities to explore a concept. These explorations allow them to make new connections and see the concept in different ways. "To achieve robust long-term understanding, multiple connections must be erected and grounded in experience…" (Clough, 2002, p.86).

Inquiry in the science classroom embodies all of the aforementioned. In addition, it follows the constructivists' viewpoints of how people learn. It enables students to better understand a concept through investigation and dialogue with peers and other who can help them make sense of what they are experiencing.

> The classroom community of inquiry is an example of constructivist pedagogy…achieved by engaging students in processes of inquiry in which they construct their understanding of a topic by means of investigation, application, experimentation, and most important, through dialogue with teachers, experts, and other students. (Gregory, 2002, p.399-400)

A teacher's role is not to tell the student what he needs to know. It has been said that even when a teacher does this, the student may not learn it (Clough, 2002, p.86). The teacher's role in the classroom is to help the students build on their prior knowledge and to act as a guide.

> …the guidance provided by the educator merely 'scaffold' the student's active intelligence in making and testing hypotheses, and never override that intelligence by attempting to 'condition' the student toward predefined outcomes on the behaviorist model of stimulus response. (Gregory, 2002, p.400)

Tytler (2002) corroborates Bybee's belief that it is crucial to understand the beliefs that a student comes into the classroom in order to effectively reach that student. Tytler states, "There is now an enormous body of research on student learning in science that focuses on the ideas students bring with them to the classroom, and how these affect how and what they learn" (14-15). Many of the misconceptions that students bring to the science classroom are a result of the misuse of common and scientific language. "Significant alternative conceptions often centre on concepts for which the common and scientific use of language differs…" (Tytler, 2002, p.15).

Tytler (2002) examines the constructivist view for the classroom. He recognizes that learning results from opportunities in the classroom in which the learner is actively engaged in a thoughtful way. The learner is not just engaged in a "recipe book" lab, but engaged in thought provoking scenarios that require them to reflect and to extend their understanding to new and different situations.

> …learning is viewed as the construction of personal meaning, and this process in the classroom is simply an extension of the same process by which the prior ideas had arisen; from students' active engagement and meaning

> making with the world, from the earliest age.(16-17)

Gallagher (2000) would suggest that learning results from being able to apply concepts to new situations. Without application, learning is not evident. When students are able to apply a concept, they are better able to see how the concept may look in the real world and how they might use it. It may also help a student to be able to see how science concepts are actually related to one another and build on one another.

> …application of knowledge is a central part of learning when it (a)helps students identify practical applications of concepts, (b)uses practical experiences and applications to make connections between concepts and 'real world' experiences in ways that enrich understanding of concepts, and (c)shows how knowledge of one set of concepts forms the foundation for learning about other concepts. (313)

Gallagher (2000) also notes that not a lot of time is devoted to helping students see relationships or to understand what they are experiencing in a science classroom. Students then may perceive that this is not a necessary step in their learning. However, Gallagher stresses that this is a vital step to learning and should not be neglected.

> Only a small portion of class time is devoted to helping students make sense of the new information and make connections among the various components of these elements of scientific knowledge in a way that leads to understanding. (311)

An effective science classroom will include some degree of inquiry in the classroom. The level of structure embedded in the inquiry activities depends on the teacher, students, and desired learning goals of the students (*Inquiry and the National Science Education Standards,* 2000, p.10).

When the National Science Education Standards were developed, the developers stated the importance of inquiry in science learning. Not only is inquiry deemed important, but also it is "central to science learning" (*National Science Education Standards,* 1996, p.2). In this sense, learning is seen as an active process. Students are required to participate actively and thoughtfully in the process. The Standards suggest that

"…science is an active process. Learning science is something that students do, not something that is done to them" (*National Science Education* Standards, 1996, p.20).

Students who participate in inquiry based science learning, find that they are being asked to ask questions, explain, test their explanations, communicate with others, apply their learning to new situations, etc. (*National Science Education Standards*, 1996, p.2). A student's knowledge and understanding is increased because they are required to formulate a reasonable explanation. This requires thinking on their part as the teacher no longer readily gives the students answers (*National Science Education Standards,* 1996).

Inquiry is not viewed as the cure all for what ails science education. Although it plays a vital role to becoming scientifically literate and students should have ample opportunities to engage in inquiry, it is not the only strategy teachers should employ. It is important for teachers to use multiple strategies to help their students to develop an understanding. The Standards (1996) state,

> Although the Standards emphasize inquiry, this should not be interpreted as recommending a single approach to science teaching. Teachers

> should use different strategies to develop the knowledge, understandings, and abilities described in the content standards. (23)

An inquiry based science classroom has a very distinct atmosphere of learning. *Inquiry and the National Science Education Standards* (2000) offer the framework of the components of an inquiry-based classroom. It has many components such as being learner-centered, knowledge-centered, assessment-centered, and community-centered. In a learner-centered environment, the teacher tries to understand where the student is at in his or her learning. She tries to understand what knowledge or skills that student is working with in order to meet the needs of that student (121).

In addition to being learner centered, the classroom is knowledge centered. In a knowledge-centered classroom, knowledge is constructed so that students understand a concept and are able to apply it to other areas. Students are continuously learning and seeing where the new learning fits into previous learning. Connections are being made as the students develop an understanding of a concept. The student doesn't merely memorize isolated facts but understands the "big ideas" that surround that concept (*Inquiry and the National Science Education Standards*, 2000, p.122).

Inquiry classrooms are assessment-centered classrooms. Assessment-centered classrooms do not mean that the teacher is going through stacks and stacks of student work trying to determine if the student understood the concept. The students take an active role in assessing their own learning and their own understanding of a concept. Assessment does not just occur at the end of a unit but is ongoing which allows for the student to correct misunderstandings because he or she is receiving ongoing feedback from the teacher (*Inquiry and the National Science Education Standards*, 2000, p.122).

Finally, inquiry classrooms are community-centered classrooms. As a class community, students reflect, articulate, and explain, concepts with each other. This helps them to better understand a concept when they are required to explain it to someone else. The dialogue rich environment allows for students to gain a deeper understanding. Students are learning from one another (*Inquiry and the National Science Education Standards,* 2000, p.122-123).

Support for Learning English and Classroom Implications

Learning English is not an easy task for the students who come into the classroom. Limited-English proficient (LEP) students, however, are guaranteed the same access and opportunities to learn as fluent-English proficient (FEP) students are. If a LEP student comes into the classroom, s/he should be allowed to participate actively and fully in the instruction that is taking place. S/He should not be excluded or sent to do other tasks while the rest of class engages in content learning opportunities. The National Science Education Standards were developed with even these learners in mind and with the belief that the standards are accessible to these students as well. "The Standards apply to all students, regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science" (*National Science Education Standards,* 1996, p.2).

One method in helping LEP students is known as "Sheltered English." In these classrooms, teachers use many different methods to help a student understand what is being said. Some of the strategies that teachers use in these kinds of classrooms include slowing down the speed at which the teacher is talking, use of context clues, using models, and relating what is being taught to the students' and their experiences. Teachers have mastered the art of speaking fast. There is a lot of material to cover in a short amount of time, so teachers seem to have sped up the pace and tone of their instruction. However, for LEP students, it is helpful for a teacher to slow down. This allows the student to hear the words better and allows time for them to comprehend what is being said.

Using context clues are also very helpful when instructing all students. Context clues can be pictures or even graphic organizers. "They also adjust the language demands of the lesson by modifying speech rate and tone, using context clues and models extensively, and relating instruction to students' experiences" (Northcutt and Watson, 1986, Parker 1987 as stated in Watson, Northcutt and Rydell, 1989, p.60). Inquiry, in the science classroom, as previously demonstrated, does all of this.

In sheltered classrooms, they feel the importance of going over vocabulary prior to a lesson in order for a student to understand the lesson. When teachers are doing these vocabulary types of lessons, they use many strategies, such as "visuals, manipulatives, and models to make the words come alive for students" (Watson et al., 1989, p.60). It will be discussed later why previewing vocabulary in a lesson, is not necessary when using inquiry in the classroom.

Teachers in sheltered classrooms strive to get their students to be active participants in the lessons. The students need to be involved in their own learning. Some of the strategies that teachers use are visuals, manipulatives, experiments, plays, realia, overheads, etc. (Watson et al., 1989, p.60). Again, inquiry-based science classrooms incorporate many of these strategies within the lessons.

In sheltered classrooms, students are encouraged to talk with one another and work with one another in small groups. Lectures should be kept to a minimum because students cannot follow for long periods of time. "Teachers in sheltered classrooms increase student interaction with content by using small-group cooperative learning and by minimizing lectures" (Watson et al., 1989, p.60). Inquiry-based classrooms use group work and minimize lecturing done by the teacher.

Specially designed academic instruction in English (SDAIE) is another powerful tool for helping students to learn a second language. There are eight components to the SDAIE strategy. They are, "connect to previous learning, visuals and manipulatives, low risk and safe environment, multiple access points, cooperative and interactive, chunking and webbing, respectful to learner, and primary language support" (Cline and Necochea, 2003, p.19).

When a teacher strives to connect new learning with what has already been learned, it helps to build schema for the student. Previous knowledge acts as a foundation in which other knowledge will be built upon (Cline and Nechochea, 2003, p.20). When a teacher tries to make a lesson accessible to a student, he or she may use visuals, manipulatives or realia. This helps to conceptualize the learning for the student. "The use of visuals, manipulatives, technology, and realia can help make a lesson 'come alive' by providing authenticity to the abstract concepts and ideas being presented" (Cline and Necochea, 2003, p.20). Multiple access points in SDAIE are the different ways that a student can learn or understand a concept. They "are the different points of entry to a unit of study that enable students at various levels to understand key concepts, participate in classroom activities…" (Cline and Necochea, 2003, p.21). In inquiry classrooms, students are given many different opportunities to explore a concept in different ways. Exploring concepts in different ways allows a student to access that information in new situations.

SDAIE lessons also involve opportunities for students to dialogue with one another. This dialogue allows them to gain a deeper understanding of content along with the opportunity to learn language skills through the modeling of their peers. "It is essential that SDAIE lessons are cooperative and interactive in order to provide opportunities for language negotiation, social construction of knowledge, and deeper understandings of key concepts…" (Cline and Necochea, 2003, p.22). Making connections, accessing prior knowledge, using visuals, manipulatives, realia, safe environments, multiple access points, cooperative grouping, chunking, etc. are all components of good inquiry.

In an article by Egbert and Simich-Dudgeon, it was stated that integrating verbal interactive activities in a social studies classroom, increases LEP students' understandings of concepts. This article is for a social studies classroom, but can be applied to a science classroom. When students are engaged in verbal activities, their understanding of a concept increases. "…non-native English language learners can and should be actively involved in verbal collaborative activities that require them to use the language of social studies…" (Egbert and Simich-Dudgeon, 2001, p.22). Egbert and Simich-Dudgeon (2001) have found that verbal interactions are essential for both native and non-native English speakers in order to gain and understanding of a concept (22). They have also found that students need to have opportunities to explain, describe, analyze, make generalizations, and connect learning to previous learning (Egbert and Simich-Dudgeon, 2001). If this is true for a social studies classroom, then one could conclude that the same would apply in a science classroom. Students, even LEP students, need to be given opportunities to explain, describe, analyze, etc. verbally with their peers. Once again, inquiry provides all of these opportunities.

A study was conducted by Saunders and Goldenberg (1999) to analyze the affects of using literature logs and instructional conversations with LEP and FEP students increase their understanding in literature. It was found in that study that when students kept a literature log, reflections of what they were learning, and when they were engaged in "conversations" with one another and with the instructor, their comprehension was increased (281). If this were to be applied to a science classroom, a teacher may use journals for students to reflect on what they are learning and use cooperative groups for discussions with their peers on what is being learned. Inquiry does this.

Inquiry and the National Science Education Standards offers a guide on how to reach English Language Learners (ELL). It is critical that the teacher of ELL students create an environment that is considered to be "learner-centered." This allows the teacher to understand the beliefs, background, and skills with which an ELL student is coming to the classroom. In addition to it being a tool for ELL students, it has already been discussed how important it is for teachers to know and understand the preconceptions that students are coming to a lesson with prior to the lesson. This helps the teacher address the needs of the student. "Therefore, learner-centered environments in which teachers build new learning on the knowledge, skills, attitudes, and beliefs that students bring to the classroom, are critical to science learning of English language learners" (*Inquiry and the National Science Education Standards*, 2000, p.122).

As previously discussed, one of the necessary components of an inquiry-based science classroom is for the classroom to be community-centered. The dialogue that occurs in the classroom is very helpful for ELL students. The discussions can act as a model for students in developing a scientific language. "'…emphasize the importance of class discussions for developing a language for talking about scientific ideas, for making students' thinking explicit to the teacher and the rest of the class…'" (*Inquiry and the National Science Education Standards*, 2000, p.123). Students who are learning a new language may struggle with written assessments. However, the dialogue that occurs during inquiry can help a teacher to better assess the learning of that student. The grade of an ELL student will not depend on just one written test at the end of the unit, but on the ongoing assessments, including dialogue, that occurs during inquiry. "Students who are still acquiring basic knowledge of English vocabulary, syntax, and semantics can have problems both understanding and responding to language-based assessment items" (*Inquiry and the National Science Education Standards*, 2000, p.83).

A key ingredient for a student to learn English is opportunity to learn vocabulary. Inquiry teaching includes vocabulary. The vocabulary that a student learns is in context and the students will be able to use the vocabulary. Students, in an inquiry classroom, build a conceptual understanding of this vocabulary as well.

> His review concludes that inquiry-oriented teaching can result in outcomes that include scientific literacy, familiarity with science processes, vocabulary knowledge, conceptual understanding, critical thinking, and positive attitudes toward science. (*Inquiry and the National Science Education Standards*, 2000, p.125-126)

In the Ontario Montclair School District, it is widely believed that students need to be presented with vocabulary before they will understand a lesson. However, in *Inquiry and the National Science Education Standards* (2000), when the question was posed of how students can do the science without the vocabulary to explain the results, it was said that just by memorizing vocabulary words doesn't mean that the student understands the vocabulary. "Knowing vocabulary does not necessarily help students to develop or understand explanations" (133). In an inquiry-based science classroom, the opportunities that students are given to explore a concept help the student to develop the vocabulary because the students have actually had an experience with what is being taught. This experience acts as a foundation for them when they are forming definitions and begin to use the scientific terms. "Rather, once students begin to build and understand explanations for their observations, the proper names and definitions associated with those events become useful and meaningful" (*Inquiry and the National Science Education Standards*, 2000, p.133).

CHAPTER THREE

METHODOLOGY

An inquiry-based science unit was created using the National Science Education Standards, California State Science Content Standards, and OMSD science standards. The research shows that inquiry-based instruction for science meets the majority of needs for all students. This science unit was the basis for the model unit discussed later in this chapter.

Bybee, along with Alesandrini and Larson, have established that the understanding of a student's prior knowledge is essential before beginning a lesson or a unit. This applies to both FEP and LEP students. Before the unit was begun, a KWL chart was started. The teacher asked the students what they already knew about plants, listing each idea under the "K" of the chart. The teacher was able to identify any misconceptions that the students may have had and was able to tailor some activities to address these misconceptions. The teacher then asked the students what they wanted to know about plants during the course of the unit. This helped the teacher to identify interest and motivation levels of the students.

The research shows that students learn best when they are actively engaged. Bybee suggested that this is a crucial first step in getting a student involved in learning. This is the first step of his teacher instruction plan. The unit began with an engagement activity. The engagement activity had the teacher eliciting questions from the student.

The unit then moved into the exploration phase. Students were placed in cooperative/collaborative groups based on interest. Watson, Northcutt, and Rydell (1989) demonstrated the need for small group interaction. Sheltered groups encourage small group interaction. The exploration phase gave students multiple opportunities to explore a concept in different situations. Multiple opportunities given to the student are similar to the multiple access points found in many SDAIE strategies (Cline and Nechochea, 2003). The students were asked to develop an experiment that would test a certain "idea" for the survival of plants.

Exploration activities were followed by a chance for groups to explain their findings to the class. Saunders and Goldenberg, along with Egbert and Simich-Dudgeon, have established the need for ELL students to have a chance to dialogue with their peers and their teacher during a lesson. The explanation section of the unit allowed the students to have ample opportunities to discuss in order to develop a deeper understanding.

Extension activities were included so the students could apply new learning to different situations. This helped them to see the connectedness of science concepts. In addition, it deepened their understanding of a concept when they saw its relationship with other concepts. Perkins and Blythe (1994) established the need for extension activities. According to Perkins and Blythe, understanding is evident when a student is able to apply what was learned to a new situation.

Finally, evaluation opportunities were ongoing throughout the unit. Ongoing assessments allowed the teacher to alter lessons and give students feedback throughout the unit. Feedback is given to help students correct any misconceptions and deepen their understanding of a concept. Ongoing assessments were used based on the research of Perkins and Blythe (1994). According to these two researchers, ongoing assessments are a key strategy in teaching for understanding. Students' thinking is clarified for them and activities can be tailored to meet the needs of the child. Furthermore, Donovan, Bransford, and Pellegrino (1999) advocated for a "metacognitive" approach to instruction. This can be achieved through "actively" seeking out what children are thinking.

The following plant unit serves as a precursor to the general model for the inquiry unit that has been described. This unit can serve as a template for any inquiry science unit.

What Do Plants Need to Survive?

The following unit is designed for a third grade classroom. The it addresses the California Science Content Standard of Life Science. It states,

> Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept: a) Students know plants and animals have structures that serve different functions in growth, survival, and reproduction; d) Students know when the environment changes, some plants and animals survive and reproduce; others die or move to new locations. (*Science Content Standards for*

California Public Schools: Kindergarten Through Grade Twelve, 1998*).*

The National Science Standard that the unit addresses is found in K-4, Life Science Content Standard C. It states,

> Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light. Organisms can survive only in the environments in which their needs can be met. (*National Science Education Standards, 1996).*

The *Atlas of Science Literacy* allows a teacher to see how the objectives are interconnected and how they build on one another. The area that this unit focuses on is the Flow of Energy in Ecosystems. The K-2 strand states that living organisms have certain requirements for their survival. Some of these needs are water, food, and air. In addition to water, food, and air, plants need to have light in order for them to survive. In third grade through fifth grade, these concepts are further built on. The students will come to realize that organisms need "energy" to stay alive and grow.

The ELD standards being addressed during the unit are numerous, see Table 1.

Many materials will be needed to conduct this unit. The materials needed are the plants for exploration, different kinds of plants to show ELD students, chart paper, markers, plant nutrients, different types of soil, and water. More materials may be needed as the unit unfolds based on student interests.

Table 1. Ontario Montclair School District English Language Development Standards Addressed for Each Language Level

Beginning: Level 1	Early Intermediate: Level 2	Intermediate: Level 3	Early Advanced: Level 4
1ELDl2: Draw pictures to demonstrate comprehension. 1ELDr3: Match pictures to words and sentences read aloud by teacher. 1ELDs2: Imitate verbalizations as comprehension increases. 1ELDw2: Draw pictures to convey	2ELDs1: Ask simple questions. 2ELDw3: Participate in brainstorming and mind-mapping activities prior to writing. 2ELDs3: Use memorized and simple formatted phrases appropriately. 2ELDw5: Combine	3ELDs2: Combine and apply previously learned material to new situations. 3ELDw2: Contribute to brainstorming and mind-mapping activities prior to writing. 3ELDc1-Describe the process used	4ELDl4: Demonstrates comprehension of formal and informal presentations. 4ELDs5: Communicates comprehensibly. 4ELDc1: Explain strategies used in solving problems. 4ELDc2: Analyze cause and effect relationships in content

meaning. 1ELDc3: Write/copy basic information about the content area.	pictures, illustrations, labels, and captions to express meaning in writing. 2ELDc4: Use common content area terms.	to arrive at an answer. 2ELDc2: Illustrate basic concepts and problems with appropriate charts, graphs, and table.	areas. 4ELDc4: Use reference materials.

There are many goals and objectives for the learner. The learner will know that plants require air, water, nutrients, space, and light in order to survive by developing and carrying out experiments that examine these different factors. An evaluation system will be used to determine the level of mastery by the student, see Table 2.

Table 2. Rubric

Elements to Evaluate	Evaluation System
Goal: • Plants need air. • Plants need water. • Plants need nutrients. • Plants need light. • Plants need space. Objective: The students will develop and carry out experiments that determine if plants	Advanced: • Students know and understand that plants need air, water, nutrients, light, and space for their survival. • Students develop and carry out experiments that examine one of these factors.

need air, water, nutrients, light, and space in order to survive.	• Students actively participate in all activities. Proficient: • Students know most of what a plant needs for survival. • Students develop and carry out experiments that examine these factors. • Students actively participate in all activities. Basic: • Students know 3/5 of what a plant needs for survival. • Students develop and carry out experiments with some guidance. • Students actively participate in most of the activities. Below Basic: • Students know 2 of the necessities for plant survival. • Students develop and carry out experiments with a lot of guidance. • Students actively participate in some of the activities. Far Below: • Students know none of the necessities for plant survival. • Students are unable to develop and carry out experiments. • Students do not

	actively participate in any of the activities.

Some background knowledge that students will need to understand falls in the Atlas K-2 strand for the concept map for Flow of Energy in Ecosystems. Students will need to understand that living things need to have some of their basic needs met in order to survive. They will need to know and understand what a plant looks like when it is dying.

Many factors affect a population's ability to survive. Some of these factors include food, water, light, and living space. Plants have the ability to make their own food when the conditions are right. Living things need water in order for their cells and tissues to function properly. Plants need light because it is needed in the process of plants making food. Finally, if there are too many organisms living in one place, there will not be enough resources for them to thrive.

Safety standards will be followed by all students. Students will use the materials only in the manner in which they are intended. Students will do all activities safely.

Behavior standards will be followed by all students. Students will respect the teacher and classmates in all activities carried out and ideas that are presented. Students will take responsibility for their own behavior as well as their own learning.

Management of materials is crucial to having a unit flow smoothly. Stations will be set up throughout the room for each group to carry out their experiments according to what they are examining. All materials will be available in the classroom prior to investigations.

The lesson will begin with an engagement activity. The engagement activity will take approximately one class period. Begin by creating a KWL chart with the students. First, ask the student what they know about plants. Write down all of their responses (even if inaccurate) on the chart under the "K" of the chart. Then ask the students what they would like to know about plants. List all of their questions about plants under the "W" of the chart. These two columns will help in deciding what areas the students have misconceptions about and what other activities may be needed to develop to address and change the misconceptions. Begin brainstorming ideas for how the students can find out what a plant needs in order to survive. Have groups brainstorm ideas in their groups. Then, after they have a chance to brainstorm, begin brainstorming their ideas on chart paper (plants need water, plants need sunlight, plants need food, plants need space, plants need air, etc.)

Show the students two plants. One plant is thriving and the other plant is dying. Ask the students, "What evidence do you see that one plant is thriving and the other dying?" Tell the students that, "One plant is in fact thriving and one is dying. Everyone had excellent questions and by focusing on one of the questions, we will probably be able to figure out the answer to some of the questions. The question that we are going to focus on is 'What do plants need to survive?'"

During this part of the lesson, many ELD considerations can be made. When listing ideas, be sure to write large enough and neatly enough for students to be able to read it. Say the word as you are writing it. Draw a picture to correspond to question (i.e. Why is one plant green? Draw a picture of a green plant next to the question.) When showing the plants, it would be helpful to show several different kinds of plants (i.e., a green plant, cactus, flowers, banzai tree, etc.) This will let

ELD students know that these are all different types of plants.

The exploration phase of the lesson will take several class periods. Before designing any experiments with the plants, the students need to establish what makes a fair test. Discuss variables with students. Tell them that if they are testing for one variable, they cannot change anything else. Everything else needs to stay the same.

Students will work in teams to explore one of the suggested needs of a plant. Each group will need to decide how they will carry out their exploration. The students need to come up with these ideas, it just might be necessary to ask them the right questions in order for them to come up with the correct suggestion. Some suggestions are:

Plants need water. To test for this variable, get two plants. One plant will be watered (1 cup every 3 days or so) and one plant will receive no water.

Plants need sunlight. To test for this variable, keep a plant in the sun and put a plant in a closet, etc.

Plants need food. Ask the students where plants get their food? Perhaps the soil? Perhaps sunlight? This will be difficult, maybe students can use a rich soil and others can use sand, etc.

Plants need space. To test for this variable, put multiple plants in a smaller area and put plants in bigger area.

Plants need air. To test for this variable, put one plant in a closed container and another in an open container.

The students need to make sure that they are only looking at one variable. For example, if they are exploring sunlight, they need to make sure all other variables are controlled for. Give the plants the same amount of water, same type of soil, etc. They will create a chart, see Table 3.

The students will observe the plants over a course of 3 weeks. They will observe their plants and keep a journal. They will take measurements of their plants at the beginning and at each observation. They will note any changes that they see in their plants and draw a picture.

Each class session, try to meet with each group to discuss progress. Allow students to report to their classmates what their findings so far are.

Table 3. Chart for Variables

Variable we will test.
Variables we will not change.
How we will test the variable.

The ELD considerations for this aspect of the unit are to: make a list of key vocabulary words (soil, sun, food, air, etc.) that the students may encounter during the course of their exploration. Write out the definition and draw a picture to represent that word. Allow students to add words to the list if they come to a word that they are unsure of. As a class, discuss the words, their meanings, and a possible nonlinguistic representation of that picture. Allow students to draw the picture. Students will draw pictures of their plants. This helps students who do not have enough vocabulary to only write an explanation. Students are working in groups, can be paired with a student who is confident in English. The student can be a good model for that student. Students are doing "hands-on" activities that are giving them experiences with the concepts that are being discussed.

The unit will then proceed to the explanation phase of the unit. This generally takes several class periods to complete. Students may want to look through their science book, or trade books related to plants, in order to find an explanation for what they discovered. They will then need to create a poster of their findings. Their poster will need to include their hypothesis (i.e. plants need water), procedure, and conclusion.
They will need to develop a "dialogue" that they will use to explain their findings. The dialogue only needs to be 4-5 lines long. This is a beneficial tool for ELD students. As the teacher you may want to model a dialogue. Example from Sutman, Allen, Shoemaker's, *Learning English Through Science* (1986), page 15:

> Gerry: Where do the stars go in the daytime?
>
> Lee: They don't go anywhere.
>
> Gerry: But I don't see any stars.

Lee: The stars are always in the sky. The stars are even there when we can't see them.

Gerry: Why can't we see them?

Lee: The sunlight blocks out the light from the stars during the daytime.

The dialogue can be adapted for use with the plant unit.

Gerry: Do plants need sunlight to survive?

Lee: Yes.

Gerry: Why do they need sunlight?

Lee: Plants need sunlight to help them make food.

The unit incorporates an extension activity as well. The extension activity takes one class period to complete. A plant is a living thing. We found that this living thing needs several things in order to continue living. What do you suppose an animal would need in order to survive?

Students will write a paragraph explaining what an animal would need in order to survive and why.

Finally, the unit reaches the evaluation portion. The teacher will evaluate the students during the course of the exploration activities (journals kept, observations made, etc.), and their explanations. The students will evaluate their own learning as well. After each of the activities, the students will reflect on what they have learned, what concepts they feel confident with, and what concepts they are struggling with. Upon completion of the unit, students will use the rubric to evaluate how well they feel that they have mastered the science content of the unit. They will submit a portfolio to the teacher to illustrate their understanding of the content. The students and teacher will set up a conference time to discuss the students' achievement of the learning goals.

For English Language Learners still at the beginning stage of language development, who may not have the writing abilities to reflect at the end of each activity, they can use a system of faces to determine understanding. A happy face means that they understand the concept, a face with the mouth drawn as a straight line would represent that they are still confused, and, finally, a sad face would represent that they are still very much confused. The teacher will need to type out content learned so that the student can draw the face next to each component. The teacher, or another student, can read the statements to the student if needed.

CHAPTER FOUR

RESULTS

The model inquiry unit just presented will lead to increased student achievement based on the research presented. Many aspects of the unit demonstrate key elements found in the research to lead to successful concept attainment by the student. The key elements incorporated in the unit are inquiry, tapping prior knowledge, active engagement, use of collaborative/cooperative groups based on student interest, dialogue among peers, applications to new situations, and evaluation opportunities that occur throughout the unit.

The *National Science Education Standards* determined that students learn best when they are engaged in scientific inquiry. The plant unit is an inquiry unit that utilizes findings from the *National Science Education Standards, Inquiry and the National Science Education Standards,* and findings from Rodger Bybee's "Scientific Inquiry, Student Learning, and the Curriculum" (2002).

Understanding a student's prior knowledge or preconceptions about a concept is crucial before beginning any unit. The lesson plan begins with a KWL chart. Bybee suggested in his research that "Teaching for conceptual change and greater scientific understanding requires systematic approaches designed to identify students' current conceptions…" (Bybee, 2002, p.28) In addition to Bybee, Alesandrini and Larson established the need for understanding a student's prior knowledge before beginning a lesson. They state, "Throughout the learning experience, meaning is constructed and reconstructed based on the previous experiences of the learner" (Alesandrini and Larson, 2002, p.118). In the unit, the teacher is required to determine what the students know prior to beginning the exploration phase of the unit. This means that students will have activities designed to meet their needs based on their understandings.

The unit requires the students to be actively engaged. Students who are actively engaged in a task tend to learn best. Active learning tends to lead to increased understanding of a concept. Perkins and Blythe (1994) suggested that, "…the mainstay of learning for understanding must be actual engagement in those performances" (6). Students are actively engaged in the unit from the very beginning. Students are asked what they want to learn about the plants, they help design the experiments to test the variables, they dialogue with one another, they apply their learning to new situations, and they are responsible for evaluating themselves. They are active participants in their learning and responsible for their learning, leading to an increased understanding.

Collaborative/cooperative group work leads to increased learning for students. The unit requires students to work in small groups during their experiments and discuss within their groups and to the class what they are discovering throughout the course of their investigations. For ELL learners, the dialogue in an inquiry classroom is essential for their language development. Cline and Necochea (2003) found that, "Optimum learning for language development occurs when the instructional setting is highly interactive and 'buzzing' with activity" (22).

Verbal discourse is essential to student achievement. Student achievement is increased in the plant unit because students are given ample opportunities to discuss their findings and progress within their group and to the class as a whole. Egbert and Simich-Dudgeon (2001) found that verbal interaction is key to learning. It allows students to formulate meaning of a concept. "…verbal interaction is fundamental to teaching and learning in general and to the learning of native and second languages in particular" (22).

Student understanding of the concepts is increased when the students are asked to apply their learning to a new situation. Perkins and Blythe (1994) have shown that understanding is increased when a student has to apply the learning to a new situation. The unit includes an extension activity that requires the students to use what they have learned about plants and apply it to animals. "…understanding is a matter of being able to do a variety of thought-demanding things with a topic-like explaining, finding evidence and examples, generalizing, applying, analogizing, and representing the topic in a new way" (5-6).

Finally, student achievement increases during the course of the unit as they are given opportunities to reflect, evaluate, and given feedback throughout their learning. Perkins and Blythe (1994) established that, "To learn for understanding, students need criteria, feedback, and opportunities for reflection…" (7). The use of journals, dialogue, and observations give the teacher and student many opportunities to clarify understanding. This can only help the student understand a concept in greater depth.

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