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Implementing a Sheltered Science Course in an Iowa High School

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Nancy L. Drescher, Chairperson

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Chapter 1: Introduction

The school-age population across the United States is undergoing a rapid demographic change. The last decade has shown a 51 percent increase in the number of English Learners (ELs) across the country (National Clearinghouse for English Language Acquisition, 2011). Within Iowa, the EL population has increased 101 percent between the1999-2000 school year and the 2008-2009 school year, from 10,310 to 20,774 students receiving language-learning services. This change has occurred while the total school-age population has suffered a decrease. The state of Iowa defines an EL as a student whose "language background is in a language other than English, and the student's proficiency in English is such that the probability of the student's academic success in an English-only classroom is below that of an academically successful peer with an English language background" ("Limited English Proficiency," 2011). Currently, Iowa does not have a mandated state EL program type, but deems the responsibility of determining the most appropriate method of English language instruction up to individual districts.

At 3.75 percent, the Iowa City Community School District (ICCSD) in eastern Iowa has a relatively small EL population in comparison to other districts across the United States (Iowa Department of Education, 2011). Even so, after Lau v. Nichols, the 1974 class action lawsuit ensuing equal educational access for ELs, it is the responsibility of each district, whether containing a small or large EL population, to provide each student with "an appropriate and meaningful education" (1973/1974).

I worked as a high school ESL (English as a Second Language) teacher in Iowa City when the district confronted the issue of how to most effectively educate ELs in content and language. The challenge for ELs who enter the school system as high school students is that they have an enormous amount of academic literacy as well as secondary-level content to obtain in a relatively short period of time. This difficulty is compounded by the fact that a significant number of the ELs entering at the secondary level are students with limited or interrupted formal educations as a result of family migrations, unequal schooling in their home countries, political unrest or even war. In response to this pressing need to teach language and content simultaneously, a science teacher and I wrote curriculum for a sheltered science course specifically for ELs in the beginning stages of English proficiency.

Conclusion

This paper will explore the research and literature available on the use and implementation of sheltered instruction (SI) as a program model for English Learners, and to raise awareness of the difficulty ELs have in acquiring both content and language acquisition at the high school level. Chapter 1 has provided an overview of the content of the paper. Chapter 2 will then provide an understanding of the challenges the traditional science content area poses for ELs, focusing specifically on students with limited or interrupted formal education, a growing area of concern for researchers and teachers of ELs. This paper will also examine the use of ELs' prior experiences and background knowledge (a key aspect SI) in developing content area knowledge. Chapter 3 will examine a high school sheltered science class taught in Iowa City, Iowa, from its initial concept, to the curriculum design, course implementation, and ultimately the curriculum revisions. Finally, Chapter 4 will review and summarize the information presented in the previous chapters.

Chapter 2: Review of Literature

Introduction

Chapter 2 will provide an overview of using sheltered instruction in the high school environment, beginning with a discussion of content-based instruction and then an overview of sheltered instruction (SI), with a specific look at the Sheltered Instruction Observation Protocol (SIOP). Next, the chapter will examine the use of SI in the high school, particularly how it functions to make content comprehensible for ELs. Then, the chapter will review the implementation of SI within the high school science curriculum, beginning with a look at science education, difficulties ELs encounter in the science content area, and ways SI can make science comprehensible. Finally, the chapter will conclude with a look at interrupted schooling and the numerous challenges the phenomena creates.

Content-based instruction

The methodology for educating English Learners (ELs) has been an evolving process over the past fifty years (Echevarría, Vogt & Short, 2008). "Changes in language teaching methods throughout history have reflected recognition of changes in the kind of proficiency learners need" (Richards & Rodgers, p. 3, 2002). Viewing grade-level curricula as necessary for ELs to catch up to their mainstream peers moved the preferred instructional strategy from the communicative approach in the 1970s toward the content-based English as a Second Language (ESL) approach in the 1980s. Content-based instruction (CBI) is an approach to language teaching in which students are taught language through the study of a particular content area. Considered to be more motivating for students than studying language alone (Chamot & O'Malley, 1994), content drives language instruction through the incorporation of reading, writing, speaking and listening tasks all related to specific topics. "People learn a second language more successfully when they use the language as a means of acquiring information, rather than as an end in itself" (Richards & Rodgers, p. 207, 2002).

How CBI is applied in the classroom currently varies across a continuum, "showcasing the shifting emphasis on content and language, most often in response to the exigencies of the instructional settings in which they are implemented" (Stoller, 2004). Language driven instruction is on one end, where the purpose of instruction is second language acquisition (occurring typically in ESL pull-out classrooms). Sheltered content classrooms are on the other end, where the purpose of instruction is comprehensible content acquisition (occurring typically in content-area classrooms taught by non-ESL teachers).

In the early stages of CBI, second language acquisition was the purpose of instruction and content was the vehicle through which this goal was achieved. Mainly ESL and Bilingual teachers employed this approach, and they used the methodology to bridge the content-area and school-based learning skills gap between ELs and their mainstream peers. "Content provides a context for teaching students learning strategies that can be applied in the grade-level classroom" (Chamot & O'Malley, p. 26, 1994). Skimming a text, taking notes, and writing comparison and contrast paragraphs are all part of the skills typically accompanying CBI. An example of a high school CBI textbook for an ESL classroom is Chamot, Hartmann and Huizenga's *Shining Star* series. Their lower intermediate level text has a unit entitled "Growing Up," which incorporates reading, writing, speaking, and listening skills by studying a social studies article about ancient kids, two literature selections: one a fable and one a myth, and a science article about the growth facts of different animals. The unit includes a grammar lesson on using conjunctions, a writing assignment incorporating descriptive sentences, and finally, a group oral presentation. Computer literacy and familiarization with the school library and research capabilities are additional aspects incorporated, as they are necessary skills for a successful transition to the mainstream classroom (Echevarría et al., 2008).

CBI in the language classroom alone has not been sufficient to aid all ELs successfully in their transition from ESL to mainstream high school classrooms. In an effort to extend the period of language support for ELs, the ESL community, in conjunction with content educators, developed the sheltered instruction approach (Echevarría et al., 2008).

Sheltered instruction

The purpose of sheltered instruction (SI) is to provide ELs with academic growth in the appropriate content area while simultaneously learning the English language. There are two primary goals in SI: one, to make mainstream, grade-level content comprehensible and accessible for ELs, and two, to use content as a vehicle to develop English language proficiency (Echevarría et al., 2008). This approach is valuable in that it attempts to provide ELs with the same cognitively demanding academic content that is simultaneously being taught in a sister mainstream class. In the same way that an umbrella provides shelter to a student in a rainstorm, SI provides shelter to an EL from the storm of classroom concepts and language. Input is made comprehensible to ELs through a series of purposeful and carefully planned steps (Echevarría et al., 2008).

Content-area teachers can provide this type of instruction with dual-certification in their appropriate area (social studies, mathematics, science, etc.) and ESL, by content-area teachers certified in their appropriate area and trained in second-language instruction, by ESL teachers alone, or through a team-teaching approach employing the knowledge of certified content-area and ESL teachers.

Curriculum design in sheltered instruction

Curriculum design in SI follows its mainstream class counterpart in order to be successful in educating ELs in content (Ortiz, 2000). It must provide students with challenging and cognitively demanding tasks, while simultaneously being comprehensible. The course goals and objectives are based on specific linguistic and content area standards, with course materials adapted to meet the needs of ELs (Echevarría et al., 2008). Imagine a teacher in the lesson preparation stage using a sand sifter to sift the material typically taught in a mainstream class. What remains inside the sifter reflects the large ideas from the content standards to be used as the content objectives of the sheltered course. The linguistic goals of the course vary depending on the academic and linguistic needs of the students, but will also ultimately match up with 1) the content objectives and 2) the TESOL state standards. At the high school level, sheltered courses allow students to earn core content credit toward graduation, rather than elective or ESL credit (Schroeder, 2011). Also, many researchers have noted that SI is most appropriate for the intermediate English proficiency level, as it demands a certain basic comprehension of English (Echevarría et al., 2008).

Sheltered Instruction Observation Protocol

Studies on SI models across the country have shown much variability in practice, methodology and outcome from classroom to classroom, school to school, and district to district. Jane Echevarría, MaryEllen Vogt and Deborah Short (2008) found the following:

> One SI classroom did not look like the next in terms of the teacher's instructional language; the tasks the students have to accomplish; the degree of interaction that occurs between teacher and student, student and student, and student and text; the amount of class time devoted to language development issues versus assessing content knowledge;

> the learning strategies taught to and used by students; the availability of appropriate materials; and more. (p. 14)

Because of this variability in practice and program outcome, Echevarría et al. (2008) developed a model for observing teachers implementing SI known as the Sheltered Instruction Observation Protocol (SIOP). Originally created as a tool for their own research in SI in the early 1990s, SIOP has become a resource for school administrators, content area teachers, and ESL teachers to use to improve upon existing or initiate new programs in SI (Echevarría et al., p. 15, 2008). The SIOP model includes the following thirty features divided into eight components:

1. Lesson Preparation
    1. Content objectives clearly defined, displayed, and reviewed with students
    2. Language objectives clearly defined, displayed, and reviewed with students
    3. Content concepts appropriate for age and educational background level of students
    4. Supplementary materials used to a high degree, making the lesson clear and meaningful
    5. Adaptation of content to all levels of student proficiency
    6. Meaningful activities that integrate lesson concepts with language practice opportunities for reading, writing, listening, and/or speaking
2. Building Background
    7. Concepts explicitly linked to students' background experiences
    8. Links explicitly made between past learning and new concepts
    9. Key vocabulary emphasized
3. Comprehensible Input
    10. Speech appropriate for students' proficiency level

11. Clear explanation of academic tasks
12. A variety of techniques used to make content concepts clear

4. Strategies
    13. Ample opportunities for students to use learning strategies
    14. Scaffolding techniques consistently used, assisting and supporting student understanding
    15. A variety of questions or tasks that promote higher-order thinking skills
5. Interaction
    16. Frequent opportunities for interaction and discussion between teacher/student and among students, which encourage elaborated responses about lesson concepts
    17. Grouping configurations support language and content objectives of the lesson
    18. Sufficient wait time for student responses consistently provided
    19. Ample opportunities for students to clarify key concepts in their first language (L1) as needed with aide, peer, or L1 text
6. Practice/Application
    20. Hands-on materials and/or manipulatives provided for students to practice using new content knowledge
    21. Activities provided for students to apply content and language knowledge in the classroom
    22. Activities integrate all language skills (reading, writing, listening, and speaking)
7. Lesson Delivery
    23. Content objectives clearly supported by lesson delivery
    24. Language objectives clearly supported by lesson delivery

25. Students engaged approximately 90% to 100% of the period

26. Pacing of the lesson appropriate to the students' ability level

8. Review/Assessment

27. Comprehensive review of key vocabulary

28. Comprehensive review of key content concepts

29. Regular feedback provided to students on their output

30. Assessment of student comprehension and learning of all lesson objectives throughout the lesson

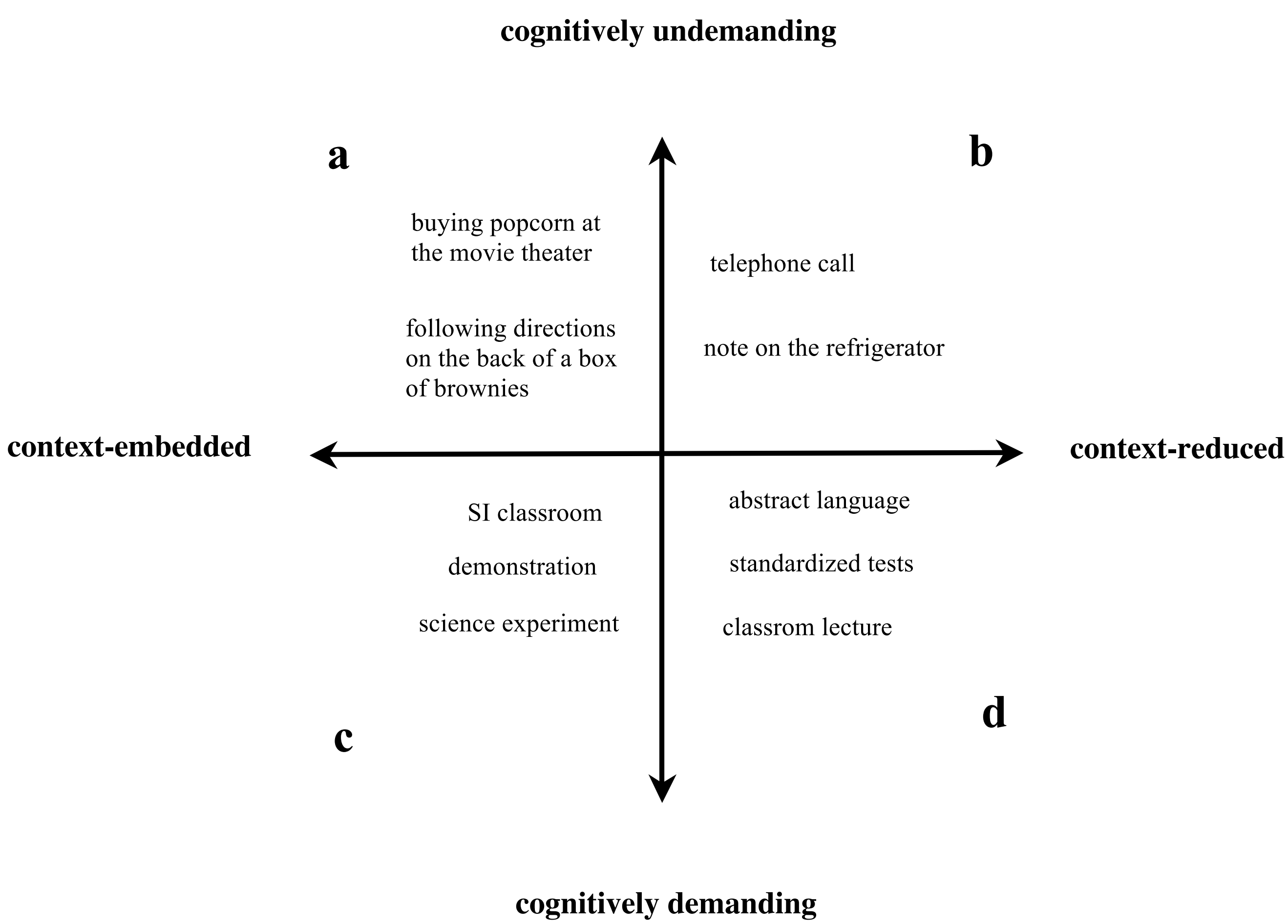
(Echevarría et al., 2008)

Sheltered instruction in the high school

Sheltered Instruction is an important instructional model in high schools because it targets the development of linguistic and academic skills that are so imperative at the secondary level (Ortiz, 2000). "On top of trying to meet high academic standards, EL students face the added challenge of learning, comprehending and applying the academic English through which teachers and textbooks deliver important information" (Schroeder, 2011). For example, in a typical history class, students might be asked to listen to a lecture unassisted by visuals, read a 12th grade academic textbook chapter, and write a comparison essay using multiple sources. Because of these high-level academic demands in secondary school curricula, SI strategies form great resources through which ELs may encounter success.

As mentioned in the example of the history class, the majority of high school classes contain high amounts of academic language with few, if any, contextual cues for ELs to derive comprehension (Ortiz, 2000). As Jose Alberto Ortiz reported in his ethnographic study of a bilingual science class in an urban high school, ELs often use and apply content related vocabulary when it is presented in a comprehensible and meaningful way (2000). Jim Cummins, a Canadian researcher who works extensively in the fields of second language acquisition and bilingualism, created a graphic to explain the four different types of tasks, and their associated language, teachers expect ELs to engage in in the classroom (Cummins, 1981). The graphic contains two continua that intersect to form four separate quadrants:

Figure 1. Cummins' Quadrants



(Cummins, 1981)

The first continuum on the horizontal axis represents the level of context within the classroom from embedded to reduced. Here, context also includes what ELs bring with them to a task (their prior learning and motivation, for example). A context-embedded task provides students with a range of additional visual and oral cues from which they are able to construct meaning. For example, head nods, gestures and intonation from the speaker, or charts, photographs, and other realia viewed in a classroom or book. A context-reduced task would be an academic lecture, a telephone call, a standardized test, or a textbook with few visuals. The second continuum along the vertical axis represents the range in difficulty from cognitively undemanding to cognitively demanding. The great number of context-reduced, cognitively demanding classes required for high school graduation furthers the appeal of Sheltered Instruction. Using SI, schools are able to transfer the academic tasks out of quadrant **d** and into quadrant **c**.

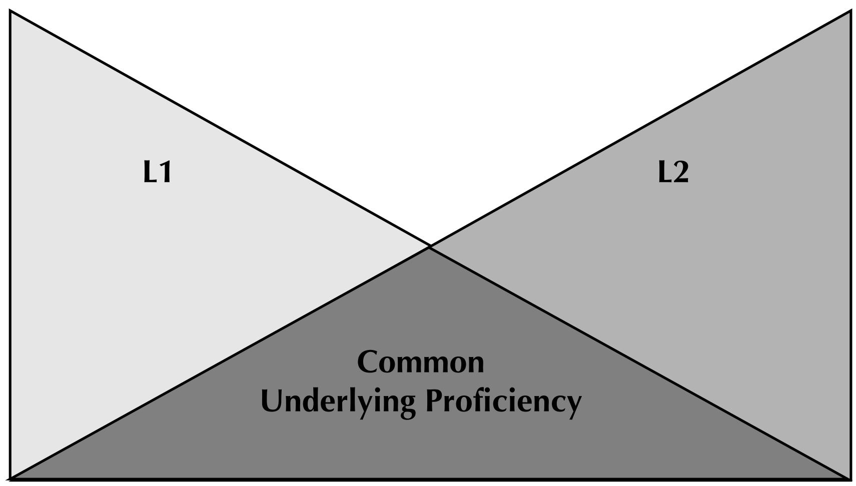
The social language required to complete tasks in quadrant **a** typically is mastered by an EL in two years (Cummins, 1981), masking the student's need for instruction in academic English (Schroeder, 2011). Targeted academic language instruction is vital to ELs, however, as their native English language speaking peers are not waiting for the ELs to catch up academically. According to Schroeder:

> A major goal of schooling for all children is to expand their ability to manipulate language in increasingly decontextualized situations. Every year, students gain more sophisticated vocabulary and grammatical knowledge and increase their literacy skills. Thus, [ELs] must catch up with a moving target. (2011)

Carlotta Schroeder found in her qualitative study of three mainstream science classrooms in Michigan that teachers reported feeling unprepared to meet the academic language needs of their ELs (2011). The teachers in her study did not have the training in SI that could further their students' academic vocabulary knowledge. Furthermore, Schroeder noted that without SI, many ELs reach the intermediate level of English proficiency and remain there. The development of their social language carries them to an intermediate level of proficiency, but then they are unable to catch up to their native English-speaking peers or flourish academically. In fact, their ease and comfort level with social English often fools teachers into believing they comprehend more academically than they actually do.

With the Common Underlying Proficiency theory (1984) Cummins explained that through the process of learning one language, a person acquires a set of skills and implicit metalinguistic knowledge that can be drawn upon when learning a second language. This interdependence of concepts, skills, and metalinguistic knowledge is what Cummins refers to as the Common Underlying Proficiency, and can be accessed through and provides the basis for acquisition of a second language. Knowing how to read and write in one language means that a student does not need to relearn the concepts in a second language (L2). The same theory is applied to science content learning: conceptual proficiency in an EL's L1 is transferred automatically to the L2 and vice versa. Also, any expansion of the Common Underlying Proficiency of one language will have a beneficial effect on the second language.

Figure 2. Common Underlying Proficiency Theory



(Cummins, 1981)

Content-area teachers often face a difficult challenge in assigning grades to ELs who are not successful in their classrooms. Carlotta Schroeder, in her 2011 study of mainstream science secondary classrooms in suburban Michigan, noted that teachers must ask themselves the following three questions when assigning grades to ELs:

1) What support structures are in place for EL students?

2) What accommodations are ELs receiving in the classroom?

3) How has instruction been modified to differentiate for language proficiency?

A mainstream content-area teacher of ELs must consider whether the students have had an equal chance of learning and mastering the curriculum, and the teacher must not fail an EL for lack of effort if the above questions were not addressed (Schroeder, 2011).

Science and Sheltered Instruction

In mainstream classrooms, science is often taught "with the expectation that all students will understand and learn when teachers present the content in scientifically appropriate ways" (Lee & Fradd, p. 12, 1998). Okhee Lee and Sandra Fradd describe scientific learning as a two-part process that is divided into scientific knowledge and scientific habits of mind (1998):

Figure 3. Components of Science Learning

Components of science learning	
Scientific knowledge	**Scientific habits of mind**
Knowing science (scientific understanding) -Building on prior knowledge -Using appropriate science vocabulary -Understanding concepts and relationships	*Scientific values and attitudes* -Manifesting generic values and attitudes -Appropriating culturally mediated values and attitudes
Doing science (scientific inquiry) -Engaging in inquiry -Solving real-world problems	*Scientific worldview* -Recognizing scientific ways of knowing
Talking science (scientific discourse) -Participating in social and academic discourse -Using multiple representational formats -Appropriating the discourse of science	

(Lee & Fradd, 1998)

The process of *Knowing science* suggests that students "not only gain an understanding of the facts and theories of science but learn the importance of scientific knowledge for solving problems in their environment" (Chamot & O'Malley, p. 26, 1994). *Doing science* through scientific inquiry is the process by which students solve real-world problems following the application of the scientific method. Through scientific inquiry students learn about systematic observation, data gathering, measuring, analyzing, classifying, organizing, predicting, and problem solving. *Talking science* is the discourse of science found within the classroom, the lab experiments, and the final reporting of scientific results. *Scientific values and attitudes* refer to "an open-minded approach to data, interest in the experimental approach, and willingness to challenge suspect information" (Chamot & O'Malley, 1994). Finally, the *scientific worldview* alludes to the shared basic beliefs scientists have about the nature of the world. That the world is comprehensible through careful, systematic study and that current understandings of the world are subject to change are two examples.

Science at the secondary level is typically taught by educators with specialized degrees in science or science education, as opposed to at the primary level where science is typically taught by the classroom teacher rather than a specialist (Chamot & O'Malley, 1994). High school students usually focus on one area of science per year, usually biology, chemistry or physics.

The education of science is a cumulative process, where from elementary, to junior high, to high school similar topics are addressed, but with increasing complexity at each level. For example, a sixth grade science book includes eight pages on inherited traits in humans. The eighth grade life science book has forty-three pages on human heredity, and still the high school biology text has ninety-one pages on the same field of study. Not only does the high school biology text have a decreased font size, but there are also fewer illustrations and the academic language becomes "denser and more decontextualized" (Chamot & O'Malley, p. 194, 1994).

Difficulties for English Language Learners in science. Concerning science education, literacy development involves abilities beyond being able to read, write, speak, and listen. With science, ELs must learn to observe, predict, analyze, summarize, and present information in a variety of formats. The components of science learning noted earlier in Lee and Fradd's chart also present difficult learning tasks for many ELs new to the science curriculum, in addition to the content-specific grammatical structures, language functions and complexity of science discourse. "Use of the passive voice, multiple embeddings, long noun phrases serving as subjects or objects in a sentence, if...then constructions, and expressions indicating causalities are some of the features of scientific prose that may be difficult for ESL students to comprehend" (Chamot & O'Malley, p. 195, 1994).

Students bring a wide range of prior literacy development to the high school science learning process (Lee & Fradd, 1998). "Important differences exist in the ways that students from preliterate and literate backgrounds use language and engage in science. [Students from preliterate societies] may substitute gestures and nonspecific terms, such as "thing" and "stuff" for precise science terms" (Lee & Fradd, p. 14, 1998). These students may have difficulty comprehending symbolic representations, and one study noted that they might not distinguish explanations from descriptions. "Preliterate science students may require many concrete experiences and opportunities to use language functions such as describing, hypothesizing, reasoning, explaining, predicting, reflecting, and imagining" (Lee & Fradd, p. 14, 1998).

Vocabulary in science is more than a list of terms to memorize. Vocabulary learning is a "complex process of developing relationships among ideas, terms, and meanings" (Lee & Fradd, p. 16, 1998). Scientific vocabulary acquisition becomes even more complex when "comparable terms and parallel ways of considering ideas do not exist across languages" (Lee & Fradd, p. 16, 1998). Also consider the classic Sapir-Whorf hypothesis (now more commonly discussed as linguistic relativity) that posits, although through much debate, the deep connection between language and culture cannot be separated. This connection gives slight differences in the meaning of a term across languages and can impede exact scientific understanding. “Even when comparable terms exist in two languages, they are often not used with the same frequency or in the same manner” (Lee & Fradd, p. 16, 1998). The resulting circumlocution by the EL to convey meaning may give the impression that the idea is misunderstood “when they simply lack the specific language or communication patterns to express precise meanings” (Lee & Fradd, p. 16, 1998). Another difficulty with the vocabulary in high school textbooks is its technical nature with numerous terms deriving from Greek and Latin. EL students from non-Western language backgrounds may have difficulty in understanding the meanings of roots and affixes from Greek and Latin (Chamot & O’Malley, 1994).

The academic focus on scientific inquiry, the *doing of science,* “by manipulating materials, making observations, proposing explanations, interpreting and verifying evidence, and constructing ideas to make sense of the world” (Lee & Fradd, p. 16, 1998) also makes learning science difficult. Carol Westby noted in her 1995 study on culture and literacy that students from oral language traditions may have difficulty using the language functions of reflecting, predicting, inferencing and hypothesizing, functions all required in scientific inquiry. Lee and Fradd note that students from cultures placing a strong value on the respect for authority may encounter difficulty inquiring, exploring and seeking alternative ways to solve a problem (1998).

Acquiring scientific attitudes and values is another realm in the EL sheltered instruction classroom that requires attention.

> The importance of enabling students to acquire scientific values and attitudes while retaining their own cultural norms is an issue that requires careful consideration. Because science is largely defined in the tradition of Western science, the nature of science is more compatible with the cultural norms of the mainstream than those of diverse cultures (Lee and Fradd, p. 17, 1998).

The greater the discrepancy between the ELs' cultural worldview and the world of science, the more difficulty the process of acquiring academic science content knowledge becomes (Lee and Fradd, p. 17, 1998). The National Science Education Standards distinguish between the scientific worldview and alternate views by stating: "Explanations on how the natural world changes based on myths, personal beliefs, religious views, mystical inspiration, superstition, or authority may be personally useful and socially relevant, but they are not scientific" (p. 201, 2010). Within the EL classroom, students from many different cultural backgrounds are joined to learn science. Some of the students tend to have "mechanistic, instrumental views that seek to explain or control natural phenomena, whereas others express alternated views in which personal, social, and supernatural forces interact with natural phenomena" (Lee and Fradd, p. 17, 1998). Okhee Lee, studying students' reactions to Hurricane Andrew in 1992, noted differences in the students' interpretations of the storm. Native English speaking students interpreted the hurricane as a natural event, but EL students expressed worldviews in which people, society and supernatural forces were responsible. "Cultivation of the scientific worldview, while recognizing and respecting alternate views, requires a great deal of sensitivity and consideration for both teachers and students" (Lee and Fradd, p. 18, 1998).

Ways sheltered instruction makes science more comprehensible for English Language Learners

Sheltered Instruction takes the teaching of an already "good" science teacher and makes it better (Echevarría and Graves, 2007). Beyond the qualities of effective teaching, SI includes wait-time, explicit vocabulary instruction, adapted content, language objectives, clarification in a student's first language, appropriate speech for proficiency level, supplementary materials and the inclusion and consideration of student background experiences.

Explicitly teaching the academic language of a content area has been considered the most important aspect of content curricula (Ortiz, 2000). Using SI as a teaching strategy is an effective method of developing academic language in ELs and the SI classroom provides a secure learning environment through which this learning takes place (Ortiz, 2000).

Incorporating students' prior knowledge into the lesson leads to increased content comprehension. Teachers must determine ELs' knowledge of a subject that they bring with them to the classroom (Lee & Fradd, 1998; Chamot & O'Malley, 1994), and from there determine the best manner to connect that prior knowledge to the current learning and ultimately the course standards. "Prior knowledge and personal experience play key roles in acquiring new scientific knowledge. Learning and understanding occur when students successfully integrate new information with prior experiences and construct new knowledge" (Lee & Fradd, p. 20, 1998). By creating ways for students to identify their prior knowledge in science, teachers "set the stage for experiences that will challenge students to refine their understanding and reformulate misconceptions about scientific phenomena" (Chamot & O'Malley, p. 200, 1994). Accessing ELs prior knowledge for this purpose is especially effective in addressing the goal *scientific worldview* mentioned earlier.

Interrupted Schooling

Part of the complexity of educating ELs is that they may come from very different backgrounds, yet still all be in the same classroom (Schroeder, 2011). They may have different levels of formal education, from no prior schooling to being highly educated; they may come from different language families, from Latin-based languages to Afro-Asiatic languages; and their familiarity in English may vary by higher or lower proficiencies in reading, writing, listening and speaking tasks even though they have all placed into the same composite level.

The process of educating ELs with limited or interrupted formal education (also known as SLIFE, Students with Limited or Interrupted Formal Education [DeCapua, Smathers & Tang, 2009]) is a particularly difficult task (DeCapua & Marshall, 2010). The many challenges faced by refugees and other EL students from backgrounds with interrupted schooling are only recently beginning to be addressed by researchers and schools (Miller & Windle, 2010). Also, despite existing methodology available to aid schools in educating these students, many educators are unsure how to proceed (DeCapua & Marshall, 2010). The Western-style model of education emphasizes "critical thinking skills and the primacy of literacy [by developing] an academic way of understanding and interpreting the world based on abstract, scientific models of thinking" (DeCapua & Marshall, p. 52, 2010). ELs that have not studied in this model have cognitively different manners of understanding the world and an academic culture with more practical and functional frames of reference (Flynn, 2007). "They have a great deal of knowledge about daily living; they have different priorities and different, nonacademic ways of perceiving and construing the world around them; and they are used to seeing learning as being of immediate benefit or relevance" (DeCapua & Marshall, p. 52, 2010). It is important that educators understand and then ultimately view and use these differences as strengths within the classroom, rather than merely as deficits, while simultaneously acknowledging the difficulties that these differences present for content learning.

SLIFE encompass ELs from many countries and backgrounds. When some enter the U.S. school system, they have never before had the opportunity to attend school. Others, however, may have been enrolled in school in their home countries for the same number of years as their U.S. peers, but have experienced limited education "whether due to lack of resources, trained teachers, the type of schooling they participated in, or other circumstances" (DeCapua & Marshall, p. 52, 2010).

The subcategory of SLIFE called refugees concerns the movement of a persecuted and/or at-war population. As of December 2009, there were more than 43 million displaced people in the world, many of them refugees (United Nations High Commissioner for Refugees, 2010). The process of resettlement from home country, through multiple refugee camps, to eventually their host country is a traumatic, educationally disruptive experience for children (Miller & Windle, 2010). Arriving in the United States and beginning school is merely one step in their long path to freedom.

"Preliterate students are like a house being built from the top down" (Brand, 2008). Arriving in the United States at the high school age is harder for ELs than at earlier stages (Miller & Windle, 2010). Because students are placed by age, not ability, they have a very short time before they graduate or must leave because they have surpassed the age limit (DeCapua & Marshall, 2010). Many of these students face low literacy in their first language, are without age-appropriate schooling and do not know how to be a student. In other words, books, pencils, papers, computers, and organized instruction may be new to them. They are unfamiliar with opening lockers, lining up correctly in the cafeteria, and completing homework assignments. For students not being able to read and write in their first language, beginning high school in the United States means having to learn a second language and literacy skills all for the first time as a teenager ((Miller & Windle, 2010).

Interrupted schooling also has the terrible consequence of leaving ELs with low literacy in their first languages (Miller & Windle, 2010). Thus, the process of acquiring a second language becomes quite difficult. Unlike students with high first language literacy, ELs with low first language literacy are not able to transfer their linguistic or conceptual knowledge of literacy from their first to second language. This process of language awareness is encompassed in what is referred to as metacognitive awareness and aids in the acquisition of new languages (Cummins, 1981; Miller & Windle, 2010).

Finally, the lack of a formal science education makes entering high school with limited or interrupted schooling difficult for ELs to complete the required science classes for graduation (Ortiz, 2000). This population of ELs is unfamiliar with many science concepts such as electromagnetism, greenhouse effect and gravity, among many others. The process of science inquiry and the discourse of science make advancing within the content at a necessary high school pace quite difficult.

Using prior knowledge with students with limited or interrupted schooling

Through the process of linking past experiences with new knowledge, information becomes comprehensible for students with limited or interrupted schooling (Pachon & Vargas, 2009; Richards & Rodgers, 2002). Students carry important experiences and information with them that teachers can access as the starting point of a theme-based lesson (Richards & Rodgers, 2002). "By linking new learning to students' personal experience or past learning, science teachers have the opportunity to assess background knowledge, promote oral language development, and create opportunities to enhance student thinking through knowledge links" (Schroeder, 2011). Without links to past learning, new information presented in a classroom can be difficult to grasp. "When there is little connection to what students already know, the concepts, skills, and ideas presented in the classroom can become a flurry of incomprehensibility, analogous to the perception of sound as white-noise" (Cline & Necochea, 2003). When students comprehend what is presented to them, natural curiosity is awakened within them creating more links to past experiences. Students are also allowed to recall facts and concepts previously learned from other classes or content areas (Pachon & Vargas), creating valuable links in their learning.

It is necessary that teachers have personal knowledge and understanding of the schemata SLIFE bring to school (Cline & Necochea, 2003). Demonstrating an understanding of the background of ELs is one way in which teachers are able to build rapport and foster a community within the classroom. Bringing the students' past experiences into the classroom creates a space and time for listening to their ideas (Pachon & Vargas, 2009). Teachers demonstrate to the students that they are knowledgeable and valuable assets to the classroom. Many students' prior knowledge is a part of their cultural history, and accessing it in the classroom pays respect to the students' culture.

Conclusion

The education of English Learners (ELs) is a dynamic and critical element in the school system of the United States. The focus in many districts over the past few decades has been increasingly on content-based instruction (CBI). This chapter began with an overview of CBI and then addressed the development and use of Sheltered Instruction (SI) in content classrooms. Then, the use of SI in the science content area was introduced, beginning with a description of what a traditional science education includes, the elements of science instruction that are difficult for ELs, and then ending with how SI is beneficial to the instruction of ELs in science. The chapter concluded with a discussion on interrupted schooling and the benefits of using SI, most specifically the ELs' prior knowledge in the content area.

Chapter 3: The creation of a sheltered instruction high school science course

Introduction

This chapter discusses the implementation of a Sheltered Instruction (SI) science course in a high school in Iowa City, Iowa. The course was designed after teachers discussed the need for the improved education of English Learners (ELs) in the Foundations of Science (a foundational, 9th grade science course) courses and the desire of the administration, school counselors, and ESL department for ELs to receive science credit at the beginning stages of English proficiency and make strides toward high school graduation. Also, with the growing number of ELs enrolling in the district with limited or interrupted formal education, the need for a course to include both content and language objectives increased. This chapter details the reasons behind the creation of the course, the design process for the first unit of the course, the implementation of Unit 1, the changes made to the curriculum after the initial unit was piloted, and then ultimately suggestions for course improvements.

The Need for the Course

During my first year of teaching high school English as a Second Language (ESL) in Iowa, I noticed on many occasions that my beginning EL students were working on homework for other classes. I periodically saw them copying the answers from other students, and I confronted them about cheating. They told me that they did not understand the material and had no other choice but to copy. They often had so much difficulty completing the worksheets for these classes that they believed being dishonest was better than failing. A few times before the students had unit tests in Foundations of Science III (FOS), I cancelled my lessons for the day and attempted impromptu science lessons myself. I empathized with these students; they wanted to learn, but so often they just could not comprehend the presentation of the material in the mainstream class.

The FOS teachers and I were in regular contact about the needs of the ELs. These teachers had large classes with diverse student populations, and they worked hard to educate all of their students. However, they also saw that they were not adequately meeting the EL students' needs. The students were falling behind in the course designed to be the third in a three-part study in foundational science. High achieving 8th graders often waive FOS for their 9th grade year to begin studying biology instead. For the rest of the 9th graders, the FOS series gives students a general science background to prepare them foundationally for high school biology, physics, and chemistry, as well as the annual Iowa City Community School District (ICCSD) 10th grade science test, which assesses material taught in the 7th, 8th, and 9th grade FOS class series. Beginning EL students were typically placed in FOS as it was viewed as cognitively less demanding than biology (thus being a good beginning point in science for Students with Limited or Interrupted Formal Education [SLIFE]). Also, the school counselors understood that ELs could not delay the start of their academic education by remaining in ESL classes and electives until they magically acquired English. Many of the SLIFE we received were older students and on a limited timeframe for learning English and graduating high school. For the ELs with previous formal educations similar to that offered in the U.S., the FOS content was thought to serve as a review of content as their academic English developed. The logic was that the students would easily be able to transfer their prior knowledge over to the material in English (Cummins, 1981), and the following year they would be ready for mainstream biology. Yet, as in the state of Iowa, only 42.9 percent of high school ELs scored at or above proficient on the Student

Academic Achievement Test in Science ("Consolidated state performance," 2009), the district decided to pilot a sheltered FOS course.

The Course Design

Thus, over the summer of 2008 I was paired with an interested FOS teacher and we were asked to design and write the curriculum for this new class which would be designed to meet the needs of beginning ELs. In the early part of the summer, we attended a Sheltered Instruction Observation Protocol (SIOP) workshop together to familiarize ourselves with the important elements in a sheltered content class (see Chapter 2). We took that knowledge and together began our task.

My co-teacher and I designed a unit entitled *Unit 1: The Nature of Science and Metrics*, roughly based off of the mainstream FOS class' first unit of the same name. The science department had previously written the curriculum for FOS, from which every FOS teacher taught exclusively. Using the same content objectives as the mainstream class' first unit, we created a coordinating list of language objectives pulled from the Iowa City Community School District's EL Student Proficiency Profile (see attachment 1). Additionally, we added content specific, key academic vocabulary and academic language structures particular to the content goals of the unit (see Unit 1: The Nature of Science and Metrics, p. 5-6).

Then, we spent time reading Grant Wiggins and Jay McTighe's Understanding by Design (2005) to create our unit. By beginning with our content and language outcomes, we worked backwards, always keeping our end goals in mind. With our learning outcomes determined, we decided on our assessment strategies: a combination of both formative and summative methods. Then we created our activities and lessons for preparing what we wanted the students to achieve. We partially used labs and activities copied from the mainstream FOS class, just adapted linguistically for our students. The Penny lab, Textbook Scavenger Hunt, the Potato Candle demonstration, and the Numbers Make Sense lab were activities the FOS teachers regularly did with the mainstream classes to familiarize the students with their textbook, the nature of science and the metric system. My co-teacher and I used those, as well, but added daily language practice activities, explicit vocabulary instruction following the Instructional Protocol for Developing Academic Expressive Vocabulary (based on *Narrowing the Language Gap: the Case for Explicit Vocabulary Instruction* by Kevin Feldman and Kate Kinsella, 2005), and small/targeted language lessons throughout such as:

- sequence words,
- the real conditional: If ___, then ____. (to articulate a hypothesis),
- the sentence structure: How many ____ equals ____?, (for metric conversions)
- the application of prefixes to the roots -meter, -liter, and -gram (for metric conversions),
- and the use of superlatives to compare items.

See attachment 2 *(Unit 1: The Nature of Science and Metrics)*

My co-teacher and I prepared for the start of the school year with anticipation and excitement. We were happy to have the unit completed, but we were very unsure of its merit and usefulness for our students. The district's English Language Intake and Assessment Center gave us nominal information about them. They were a very diverse group from thirteen different countries: Ecuador, Ethiopia, Turkey, Puerto Rico, Jordan, Vietnam, Mexico, El Salvador, Mali, Haiti, China, Korea and Saudi Arabia. They ranged in age from fourteen to twenty years old and had many reasons for coming to the United States. A few were the children of visiting University of Iowa scholars or professors and were very well educated in their first languages. Some were recent immigrants to the U.S. having moved here with their parents who were searching for employment. Two of the boys were left in their home countries as babies with extended family, then recently sent for from their U.S. established parents and new, unknown siblings. Two other boys, both from divorced families, were recently sent for from their relocated fathers who had remarried American women. Finally, five of the students were recently resettled refugees.

Each EL student entering the ICCSD is identified through a home language survey given to every new student enrolling in the district. Once noted that a language other than English is spoken in the home, the students are sent to the district English Language Intake and Assessment Center to determine their level of English proficiency, enrolled in school and the family receives information about educational programming and community resources ("English language intake," 2009). Based on the results of their assessment, students are offered EL services, which they may accept, or decline.

For the 2008-2009 school year, all beginning EL students enrolled in our district were placed in two periods of content-based ESL instruction, one period of EL Reading Strategies (taught by an English teacher), and the sheltered FOS for ELs course. The additional three periods were typically a math course (varying from Math Skills to Calculus) and two electives selected based on interest through consultation with the student's counselor.

The Implementation of Unit 1

Thus, at 8am in August, my co-teacher and I met these new faces with somewhat confused expressions. We greeted each student and instructed him or her to sit at a lab table. We began our Bell Work planned for day 1: *Sharing Around the World*.

As we moved through the first week's plan, we learned about our students' backgrounds, both educationally and culturally. We saw a division quickly develop between those students who were comprehending our material and those who were not. The students who came to our class with prior formal education were able to master our introduction to the textbook. They were familiar with secondary level texts and had little difficulty learning the new English words for *title, chapter, heading*, etc. As noted by Cummins (1981; 2001), this skill (using a textbook) already existed for them conceptually, so they did not need to relearn it in English. It was a simple process of acquiring new labels or “surface structures” for a conceptual skill they already had mastered. Our refugee students were able to parrot the English words back to us when requested, but they had no prior experiences with reading secondary textbooks. They had never had to use a glossary or index before, so learning the words in English held little meaning for them. Even after being shown how to use the index of the text, the concept was not helpful or meaningful for them because they had never before needed to look up a topic in the index of a science book. Eventually, though, we abandoned the mainstream textbook entirely as it was deemed too context-reduced and at too high an English proficiency level to even use as a periodic support.

Still, we wanted to keep the pace of our class so we moved on to studying metrics. Most of the students were familiar with the words kilometer and meter, and that background served as a base to our lesson. The language lesson on the prefixes *centi-, deci-,* and *kilo-* was understood. The students were able to comprehend that *deci-* represented ten, for example, but the conversions were very difficult for the students without prior or recent math classes. To complicate things, some of our other beginner ELs in the class were taking Calculus as their math. Needless to say, this showed us another huge gap in our students’ content comprehension.

The largest difficulty of this first unit and a precursor of what we would experience in the future came when we attempted our labs: initially the group station work about metrics and then the Penny lab. As reported by Lee and Fradd (1998), many of the SLIFE lacked backgrounds in scientific inquiry and the application of the scientific method. Therefore, completing a laboratory experiment according to a definite scientific process proved to be a challenge, even in a class of only twenty students with two teachers. Many students lacked the required English proficiency for participation in the social and academic discourse necessary for a lab experiment. Thus, communication was an obstacle. Also, personality and cultural differences made group work for some complex.

For that first lab, we grouped the students by gender, and then within each group we attempted to include students from a variety of linguistic, cultural, and educational backgrounds. While we attempted linguistic diversity to some degree, we did follow advice from Cummins (1998) in his observation that allowing students (while participating in cooperative learning activities) to use their L1 for discussion purposes (not for final draft of work if not a bilingual classroom) allows teachers to present more cognitively demanding material than the students might otherwise be able to comprehend if the teacher were to enforce an English-only rule during group work. Interestingly, even through a mix of languages, we encountered few challenges with the female groups. They worked well together as teams, assisted each other with following the steps of the scientific process, and used a combination of English and their L1s to learn the content. We did not see at the time, however, that these polite, cooperative groupings tended to obscure a couple of the female students' lack of content comprehension.

The male students presented us with different hurdles and ultimately monopolized our and the entire class' attention. They had the same communication and content struggles as the female groups, but instead of some of the students' lack of prior experiences being masked by group harmony, it was displayed prominently through competitive behavior. During our initial lab day, when students first had to practice measuring the lengths and widths of tables and chalkboards in the classroom, we experienced an argument that turned into a fight in five languages: Oromo, Spanish, Korean, French and English.

It appeared that the males were not used to group work where collectively they would follow a process and reach an answer. Many of the males wanted to dominate the group even when they lacked scientific knowledge, and this frustrated and then angered the other group members who felt they comprehended more and, thus, ought to be the leader.

As labs that were supposed to be completed in a day and a half dragged out to four day long events, we knew that our curriculum needed to be reworked. Initially we wanted to keep the pace of the other FOS classes, but this left the ELs with little content growth and our curriculum with no time for language instruction. We pushed them along, though, knowing the curriculum was failing, and administered the summative test a week after the mainstream FOS classes. A majority of the students failed. We did not know how to proceed– we had only written the first unit over the summer, and we were both swamped with other classes and school responsibilities. Moreover, we did not have common planning times, so communication over successes and failures was hard to achieve.

Reorienting Our Teaching

Feeling very disappointed with ourselves, my co-teacher and I took the FOS curriculum for the next unit and attempted small linguistic adaptations to make it appropriate for our ELs. Realizing that we needed an additional assessment tool beyond our labs and summative tests (Echevarría et al., 2008), we added a journaling assignment (see attachment 3). Students wrote one to two sentences each night documenting what they learned that day in class. At the end of each week, the students had to compile the sentences into a complete paragraph to be assessed.

They were required to use vocabulary from the class, and sentences could be written either in the present or past tense.

We also began a daily question that the students had to copy from the board at the beginning of each class. We gave them five minutes to draw, write or in some manner represent an answer. As suggested by Echevarría et al. (2008), we instructed the students in the application of various graphic organizers to organize and convey their ideas for this purpose, as well. This served as a content review, assessment tool, and time for practicing *question & answer* formats as a class.

Many of the students expressed their desire to have a textbook to use at home to reinforce concepts we were studying in class. We discovered the website *Science A-Z* which offers downloadable, leveled readers on process science (hypotheses, drawing conclusions, identifying and controlling variables), physical science (solids, liquids and gases; light; and properties), and earth science (water, the solar system, and climate). These served our class well to differentiate reading levels that existed even within the beginning proficiency level. Moreover, many of the titles were available in French and Spanish, as well. This was a tremendous resource for our French and Spanish speaking students, but a frustration for our students from other language backgrounds. My co-teacher and I were conflicted about whether to even offer those titles in Spanish and French if we did not have them available in all languages, but ultimately decided that offering some L1 support, and demonstrating its educational value, to the extent that we were able was the best option pedagogically (Cummins, 2001). We decided that we would ask more proficiently bilingual English/L1 speakers of the remaining languages for translation help of the readers for future years.

Still, with these additions, we did not feel successful as teachers. All of their assessments (the journals, daily questions and answers, group labs and summative unit tests) showed their lack of content development, and the class grew further and further behind the mainstream. My co-teacher and I felt that our entire framework for educating this group needed to be reworked the following year. Instead of following the mainstream FOS linear model of curriculum that moved from the nature of science, to physics, to earth science and then astronomy by separating the areas into four distinctive blocks of learning, we would approach the course from a more holistic and ELL-centered viewpoint. We decided that we would abandon the old curriculum entirely and begin the planning of each new unit through explicit incorporations of the ELs' prior knowledge and experiences.

We moved from mirroring the secondary textbook and mainstream FOS layouts, to creating our own progression through the content. We began with astronomy, and then interwove the nature of science, physics and earth science throughout the course where they made sense topically, rather than presenting them in isolation and separating themes from the larger story of science.

Adopting astronomy as the new starting point, we opened the unit with the ELs' personal experiences with the moon: a myth from a grandfather about a rabbit's face on the moon, a boy from a coastal town's observation of the tidal changes around a full moon, or a Muslim student's experience of celebrating Ramadan (the Muslim holy month) each year eleven days earlier than the last, as it follows the cycles of the moon rather than the Gregorian calendar. Students were asked to write, and then share, the story of their personal experience. Later, as a class we began the astronomy unit, by focusing on the scientific explanations for the students' experiences. We continued to use the FOS content goals and the majority of their labs, but integrated each goal into the varied experiences of our students. I continued to incorporate explicit language instruction with each lesson, and what we created ended up being a more purposeful incorporation of the students' prior knowledge, science instruction, and English language instruction. The following is an outline of the new portfolio students developed for the class, beginning with astronomy, moving into climate, and then onto weather. As a final project, the students created a book (the portfolio) containing all of the components below. Although these elements were created in a sequence, once a student's comprehension of an earlier topic increased, they were allowed to rewrite and reexplain the scientific conclusions included throughout.

EL Science Portfolio

I. Astronomy

   A. EL's "Moon Story"

      1. The student's personal experience/memory of a family story, myth or cultural belief concerning the moon

      2. Scientific explanation of personal moon story

   B. Calendar

      1. "Moon Data" (see attached) collected for one month in Iowa City

         a. include patterns identified and a summary of findings on last page

      2. "Moon Data" collected for home town in home country, using www.timeanddate.com

      3. Conclusion about both calendars

         a. identify similarities and differences between moon activity in Iowa City and home country using a Venn Diagram

         b. identify possible explanations for differences (return to complete this portion of book after we begin the section on latitude)

II. Transition from Astronomy to Climate (by focusing on latitude)

A. EL's outdoor experience story (connecting temperature and time of year)

1. Outdoor experience in home country

2. Outdoor experience in Iowa City

B. Data for both locations

1. One table for Iowa City and one table for home country with the following information

a. latitude

b. average temperature for each season

c. average day length for each season

2. Diagrams of the sun and the position of the earth on its axis during the four seasons. Students will highlight locations (showing latitude) of the two places.

3. Conclusion: cause and effect paragraph (or other graphic representation) explaining relationship between latitude (cause) and the seasons (effect).

III. Climate

A. Create map of home country

1. Show important factors affecting the climate (distance from the sea, ocean currents, direction of prevailing winds, relief, and proximity to the equator)

2. Conclusion: How do these factors support the climate in your home country?

B. Create map of Iowa

1. Show important factors affecting the climate (distance from the sea, ocean currents, direction of prevailing winds, relief, and proximity to the equator)

2. Conclusion: How do these factors support the climate in Iowa?

C. Conclusion: compare and contrast the two climates

IV. Weather

A. Chart with a 7 day track of weather in Iowa City including the time, temperature, cloud cover, humidity and barometric pressure

B. Using the internet, chart a 7 day track of weather in home city including the time, temperature, cloud cover, humidity and barometric pressure

C. Write a definition of weather: specific time, specific location

D. Using the information from the two charts as evidence, write a description of the weather in both locations

We completed this portfolio project with more student success than we had with the earlier unit. The inclusion of the students' prior experiences served as valuable starting points to teach new science content. The comparisons between the students' home countries and Iowa City also proved to be topics of high interest and occasionally much humor to the ELs. The students' cultures were valued, the students were given the opportunities to be the knowledgeable person in the classroom, and they also learned even more about their own experiences and countries. On average, students were highly engaged and motivated.

Recommendations

At the end of the year, my co-teacher and I still believed that the EL students enrolled in the sheltered FOS class were not receiving the same depth of instruction that the mainstream FOS class received. We did not think that the students finished the year with the same level of content proficiency as their English-speaking peers. One possible origin of the inferior content development could be from the inherently difficult nature of learning secondary-level content at the very early stages of language acquisition, thus explaining why SI is so often postponed until the high-beginning levels of language proficiency at a minimum (Echevarría et al., 2008). The following are my recommendations for a future sheltered FOS course:

1) Adopt a content, age and English language level appropriate textbook for the students to use as reference. We sampled many from different publishers and could not find one that we viewed as appropriate with respect to all three of those areas.
2) Find or create content resources in every student's L1. Without these resources, placing an LL in a sheltered course at the beginning language proficiency level is very difficult.

3) Provide the ESL and science teachers with common planning times to increase teacher communication and lesson preparation time.
4) Research the inclusion of prior experiences and background knowledge in curriculum design to determine if they could more effectively be used in the program.
5) Research successes and failures of similar programs in the U.S. in order gain more knowledge on sheltered classes and science.
6) Increase SIOP training for both teachers to promote a further increase in comprehensible input and teaching strategies that align with ESL and science best practices.

Conclusion

In the Iowa high school discussed in this chapter, the Sheltered Instruction (SI) model provided many successes and failures. Initially, the curriculum lacked the strong integration of EL prior knowledge that the SIOP model, as well as SI in general, promotes. My co-teacher and I also failed to account for the lack of scientific knowledge the Students with Limited or Interrupted Formal Schooling (SLIFE) would have and the challenges that would bring to the scientific process. And finally, the pace of the class in comparison to the mainstream FOS classes frustrated us. The successes of the model were many: an increased EL profile in the school resulting in more overall awareness of second language acquisition struggles for teenage learners; EL access to cognitively demanding, context-reduced lessons; an increase in perceived value of home culture as a result of the intensive access of prior experiences and knowledge; an increase in student English language proficiency through the daily language objectives; and the successful development of assessment tools that allowed the students to demonstrate their comprehension of content through a variety of means.

Chapter 4: Conclusion

This paper has examined sheltered instruction (SI) as a method of educating English Learners (ELs) in the United States, specifically within the Iowa City Community School District. Chapter 1 provided a brief statistical look at changes occurring within the EL population across the U.S. and within the state of Iowa over the last decade. The Supreme Court ruling on Lau v. Nichols (1973/1974) ensued equal, appropriate, and meaningful educational opportunities for all students, but leaves the program model decisions up to individual states. Iowa leaves the decision up to individual districts, thus creating much room for creativity in the classroom, yet also much uncertainty when trying to determine the best method for educating ELs.

Sheltered instruction is derived from the idea of content-based instruction (CBI), in which language is taught via a specific content area, i.e. social studies or science. Learning a language through content is thought to be more motivating for students than learning a language for the sake of the language only. Chapter 2 discusses how CBI typically functions in the English as a Second Language (ESL) classroom and explains that CBI and SI currently exist across a curriculum continuum, where CBI is on one end with language acquisition as its main goal, and SI is on the other end with content acquisition as its main goal (Stoller, 2004).

In response to a great deal of variability in SI implementation across states, districts and classrooms, Echevarría et al. (2008) developed the Sheltered Instruction Observation Protocol (SIOP) as a means for administrators and teachers to improve and monitor their own SI practices. It includes thirty key lesson features divided into eight components to aid teachers and administrators in the development, implementation, and improvement of teaching ELs.

Chapter 2 continued with a discussion on the traditional science curriculum of U.S. schools. As Lee and Fradd (1998) explain, the focus is typically on *knowing science*, *talking science*, *doing science*, *scientific values and attitudes*, and *the scientific worldview.* Difficulties ELs have with science discourse at the high school level were addressed, as well as the challenges students with limited or interrupted formal schooling encounter. The use of incorporating ELs' prior experiences and background knowledge, an important aspect of the SIOP model, was also discussed.

Finally, Chapter 2 examined the EL population entering the high school system with limited or interrupted formal education. As many of these students have not experienced the Western-style model of education that emphasizes critical thinking skills and abstract, scientific models of thinking (DeCapua & Marshall, 2010), many teachers are unsure how to proceed with educational decisions. Interrupted schooling also has the terrible consequence of leaving ELs with low literacy in their first languages (Miller & Windle, 2010). Thus, the process of acquiring a second language becomes quite difficult. Unlike students with high first language literacy, ELs with low first language literacy are not able to transfer their linguistic or conceptual knowledge of literacy from their first to second language (Cummins, 1981; Miller & Windle, 2010).

A teacher accessing ELs' prior understanding of science concepts is especially important when students have limited or interrupted formal educations. Through the process of linking past experiences with new knowledge, information becomes comprehensible for students (Pachon & Vargas; Richards & Rodgers, 2002). Students carry important experiences and information with them that teachers can access as the starting point of a theme-based lesson (Richards & Rodgers, 2002).

Chapter 3 addressed the implementation of a sheltered science course for ELs in a high school in Iowa City, Iowa. High school achievement tests in science show only 42.9 percent of EL students scoring at or above proficiency across Iowa, a rate significantly lower than that for all other students ("Consolidated state performance," 2009). This disparity in content knowledge, combined with concerns for academic language acquisition and progress toward graduation, propelled the district to create a sheltered science course. Curriculum design, implementation and eventual revisions are all detailed within the chapter.

Sheltered instruction offers the possibility of successful educational experiences for ELs in high school. Language and comprehensible content are taught simultaneously, allowing students to make vital progress toward graduation and academic literacy in English. Successful implementation of SI greatly depends of the amount of time teachers have to create curriculum, their knowledge of students' linguistic needs, and their incorporation of the students' prior scientific experiences. Creating SI programs for ELs also are more successful if students enter the class with at least a high-beginning level of English proficiency.

Attachment 1

ICCSD K-12 ENGLISH LANGUAGE LEARNER STUDENT PROFICIENCY PROFILE

(adapted from 2007 Iowa English Language Proficiency Standards & ICCSD K-6 Student Proficiency Profile)

KEY: S = sometimes **U** = usually **A** = always

<table>
<tr><th>Proficiency Level</th><th>Pre-production
Iowa ELDA: Level 1
TESOL Level: Starting</th><th>Early Production
Iowa ELDA: Level 2
TESOL Level: Emerging</th><th>Speech Emergence
Iowa ELDA: Level 3
TESOL Level: Developing</th><th>Intermediate Fluency
Iowa ELDA: Level 4
TESOL Level: Expanding</th><th>Fluent
Iowa ELDA: Level 5
TESOL Level: Bridging</th></tr>
<tr><td>LISTENING</td><td>♦ Understands few words S U A
♦ Derives meaning from context with visual support S U A
♦ Interacts nonverbally S U A</td><td>♦ Understands key words and phrases S U A
♦ Follows simple directions S U A
♦ Understands simple, context rich yes/no ?s S U A</td><td>♦ Understands simple sentences in sustained conversation S U A
♦ Demonstrates comprehension if some support provided S U A
♦ Hears small elements of speech S U A
♦ Understands simple oral story S U A</td><td>♦ Understands discourse level social language S U A
♦ Participates in gen ed content area discussions with rephrasing, repetition, & visuals cues needed S U A
♦ Participates in ELL classroom discussions with little repetition, rephrasing, or clarification needed S U A</td><td>♦ Understands material that is comprehensible to peers of the same age and educational background S U A</td></tr>
<tr><td rowspan="2">SPEAKING</td><td rowspan="2">♦ Names concrete objects S U A
♦ Repeats words and phrases S U A
♦ Responds by pantomiming, gesturing, or drawing S U A
♦ uses greeting s S U A</td><td>♦ speaks in 2-3 words or phrases S U A
♦ responds to rote survival questions S U A
♦ Uses memorized chunks of language S U A
♦ forms telegraphic ungrammatical ?s S U A</td><td>♦ Produces complete sentences S U A
♦ Relates personal experiences with repetition and clarification needed A U S
♦ Gives short answers in gen ed classroom S U A
♦ Initiates conversations S U A
♦ Asks and responds to simple questions S U A
♦ Relates academic information in ELL classroom S U A</td><td>♦ Produces language at discourse level S U A
♦ Relates personal experience clearly S U A
♦ Speaks in extended sentences in gen ed classroom regarding academic subjects S U A
♦ Self corrects S U A</td><td rowspan="2">♦ Speaks in a way that is comparable to peers of the same age and educational background S U A</td></tr>
<tr><td colspan="3">♦ Grammatical errors affect meaning A U S
♦ Vocabulary exhibits variety and sophistication S U A
♦ Exhibits control of following syntactic elements in speech:
o Subject/verb agreement S U A
o Comparatives S U A
o Question formation S U A
o Tense S U A
o Negatives S U A
o Articles S U A</td></tr>
</table>

ICCSD K-12 ENGLISH LANGUAGE LEARNER STUDENT PROFICIENCY PROFILE

(adapted from 2007 Iowa English Language Proficiency Standards & ICCSD K-6 Student Proficiency Profile)

KEY: **S** = sometimes **U** = usually **A** = always

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Iowa ELDA: Level 3
TESOL Level: Developing</th><th>Intermediate Fluency
Iowa ELDA: Level 4
TESOL Level: Expanding</th><th>Fluent
Iowa ELDA: Level 5
TESOL Level: Bridging</th></tr>
<tr><td rowspan="2">READING</td><td rowspan="2">♦ Participates in shared reading activities S U A
♦ Recognizes concepts of print S U A
♦ Has knowledge of letter names and sounds S U A
♦ Engages in aural and visual prereading activities S U A</td><td rowspan="2">♦ Relies on predictability of text and teacher support to comprehend S U A
♦ Applies concepts of print independently S U A</td><td>♦ Recognizes some sight words as appropriate to grade level S U A</td><td>♦ Reads discourse level nonfiction and fiction text independently as appropriate to grade level S U A</td><td rowspan="2">♦ Reads in a way that is comparable to peers of the same age and educational background S U A</td></tr>
<tr><td colspan="2">♦ Uses a variety of strategies to comprehend text S U A
♦ Demonstrates fluency, accuracy, and expression as appropriate to grade level S U A
♦ Uses appropriate resources to gather information S U A
♦ Uses cueing systems as appropriate to grade level S U A</td></tr>
<tr><td rowspan="2">WRITING</td><td rowspan="2">♦ Expresses meaning through drawing S U A
♦ Can copy letters/words S U A</td><td rowspan="2">♦ Expresses limited meaning through writing letters and/or familiar words and using environmental print S U A
♦ Labels drawing S U A</td><td>♦ Writes words and simple sentences using invented spelling S U A
♦ Applies conventions of writing as appropriate to grade level S U A
♦ Meaning is evident to reader S U A</td><td>♦ Writes complex sentences S U A
♦ Makes corrections with assistance S U A
♦ Organizes writing as appropriate to grade level S U A
♦ Writes for a variety of purposes appropriately S U A</td><td rowspan="2">♦ Writes in a way that is comparable to peers of the same age and educational background S U A</td></tr>
<tr><td colspan="2">♦ Exhibits fluency and expression in writing S U A
♦ Grammatical errors affect meaning A U S
♦ Vocabulary exhibits variety and sophistication S U A
♦ Exhibits control of following syntactic elements in writing:
Subject/verb agreement S U A
Comparatives S U A
Question formation S U A
Tense S U A
Negatives S U A
Articles S U A</td></tr>
</table>

Attachment 2: *Unit 1: The Nature of Science and Metrics*

ICCSD
Iowa City Community School District

Unit I: The Nature of Science and Metrics

A Content Based ELL Unit of Instruction for Foundations of Science III-L

By: Jenifer Secrist & Erin Johnson
Summer 2008

ABSTRACT

The Nature of Science and Metrics is a content-based unit of instruction designed to be the first unit in a series of twelve for the Foundations of Science III-L course. The curriculum is intended for beginning and low intermediate English Language Learners. Its goals reflect those of the ICCSD ELL Student Proficiency Profile levels 1-3, and the ICCSD Science Standards. *The Nature of Science and Metrics* answers the following essential questions

- How do we use our textbook?
- How do we use the metric system to make measurements?
- How do we apply the scientific method?
- What structures are needed to make, convert, and compare metric measurements?
- What vocabulary is needed to make, convert, and compare metric measurements?
- What structures are needed to develop a hypothesis, develop a procedure, draw conclusions and distinguish between fact and inference?
- What vocabulary is needed to develop a hypothesis, develop a procedure, draw conclusions and distinguish between fact and inference?

There are 2 parts to the unit
Part I: The Metric System
Part II: Applying the Scientific Method

Table of Contents

Course Description

Foundations of Science III –L follows the same content standards as Foundations of Science III, which is the final in a series of courses that serve as the foundation for all upper level science courses in grades 10, 11, and 12. This course addresses the ICCSD standards and benchmarks in scientific inquiry, the nature of science, physical science, and earth science, as well as the goals reflected in the ICCSD K-12 Student Proficiency Profile levels 1-3 for English Language Learners. Students are guided in fully developing the laboratory skills and thinking processes required in subsequent science courses, while simultaneously building their cognitive academic language proficiency. The content focus is on four areas of study:

Nature of Science: Students propose and answer questions that allow them to construct rational understandings of their world. Students learn proper methods and tools for scientific investigation. Students learn criteria to apply in evaluation of scientific and non-scientific claims. Students expand their understanding of how science and technology effect changes in our society.

Physics: Students are introduced to how things move and why. They learn fundamentals of energy and momentum and their conservation. Students develop a basic understanding of the electromagnetic spectrum. And students are introduced to how energy is transmitted through waves.

Earth Science: Students develop an understanding of the patterns and cycles within the geo-sphere. Physical science concepts are related to earth science with the content focus on tectonics, earth quakes, and volcanoes. Students build a basic understanding of characteristics of the atmosphere and the causes of different kinds of weather.

Astronomy: Students broaden their understanding of the solar system, stars, and galaxies. Focus is on the comparison of celestial objects with in the solar system and beyond. We compare and contrast object dimensions, interactions, evolutions, and histories.

Unit Goals

Content: **ICCSD Science Standards & Benchmarks**
Strand I: Construct new Scientific and Personal Knowledge
Standard 1: Ask questions that help construct meaning about the natural world.
1) Develop questions or problems for investigation that can be answered empirically.
Standard 2: Design and conduct investigations using appropriate methods and tools.
1) Design and conduct scientific investigations.
2) Recognize and explain the limitations of measuring devices.

Language: Students will increase academic discourse competencies (ICCSD ELL SPP levels 1-3)

Instructional Objectives

Content Objectives:
Students will be able to

- make metric measurements
- make metric conversions
- develop a hypothesis
- develop a clear procedure
- identify variables
- collect data
- analyze data
- draw conclusions and make questions
- distinguish between fact and inference
- use appropriate lab materials

Language Objectives:
Students will be able to

- derive meaning from context with visual support (SPP L1)
- understand key words and phrases (SPP L2)
- hear small elements of speech (SPP L3)
- demonstrate comprehension with support (SPP L3)
- name concrete objects (SPP S1)
- repeat words and phrases (SPP S1)
- respond by drawing (SPP S1)
- use memorized chunks of language (SPP S2)
- give short answers in general education classroom (SPP S3)
- ask and respond to simple questions (SPP S3)
- produce complete sentences (SPP S3)
- participate in shared reading activities (SPP R1)

- rely on predictability of text and teacher support to comprehend (SPP R2)
- express meaning through drawing (SPP W1)
- use environmental print (SPP W2)
- write words and simple sentences using invented spelling (SPP W3)

Students will know
- key academic vocabulary
- key academic language structures
    - sequence words and the command form to write a procedure: *First, fill a cup of water*.
    - the real conditional: *If ____, then _____*. to articulate a hypothesis
    - *How many _____ equals ______?*
    - the application of prefixes to the roots –meter, -liter, and –gram to make metric conversions
    - the use of superlatives to compare items in their study of metrics

Assessment

The classroom assessment comprises of both formative and summative methods. Each content objective is linked to various classroom tasks (see Attachment A). Completion and performance of these tasks assesses learning and is viewed as a portfolio of student understanding. Daily bellwork, journaling and wrap-up activities allow opportunity for informal and formative assessment, as well.

Summative assessments will occur during a Metrics Practical, where students perform metric measurements as instructors observe, and the final unit exam.

Philosophy and Teaching Methods

Students learn by constructing knowledge and connecting it to something they already know. Each student enters this course as an English Language Learner at his or her specific ability level. Instruction is differentiated to meet the various needs of each student. Differentiation occurs through the use of various teaching modalities and alternative forms of delivering content, activities, and assessments. Our assessment takes multiple forms and addresses various language and cognitive ability levels, focusing on content and language objectives. Teacher assessment, peer assessment, and self assessment are used with a variety of formats, to ensure greater accuracy in our assessment process. The class is inquiry based, designed for students to discover their own understandings, and then reinforce their created knowledge through class activities, seat work, homework, and group discussion. Students are encouraged to work collaboratively, gaining new perspectives as they develop their language proficiency.

Instructional Protocol for Developing Academic Expressive Vocabulary

(based on work by K. Feldman, and K. Kinsella, 2006)

1. Students complete word rating for today's word(s). (NOTE: Teacher posts word(s) and accompanying structure for viewing)
2. Students copy new word and accompanying structure in "partner practice" section of Tool Word Sheet.
3. Teacher contextualizes word within the lesson. (Today's question is about....)
4. Teacher says word, asks students to repeat several times, first chorally, then individually.
5. Class spells the word together.
6. Teacher provides accurate, brief, accessible definition. (Use *Longman Study Dictionary* for definition)
7. Students write definition on Tool Word Sheet.
8. Teacher provides 2 oral examples using varied, rich contexts. Teacher writes for all to see.
9. Students copy examples onto Tool Word Sheet.
10. Teacher tells or asks what kind of word it is, class decides, and circles correct part of speech.
11. Class generates synonym and antonym (if appropriate) and students copy onto Tool Word Sheet.
12. Class generates other words in word family.
13. Teacher engages students in activities using the word. ("Show me a face that tells how you would feel if..." "Turn to your partner and tell them a time when you..." Examples and non-examples ("If this sentence is an example of _____, then say the word.")
14. Students practice word with partner using provided structure.

NOTE: After each section of the unit, students self-assess vocabulary acquisition of words in that section by completing the word stems in column 3 of Vocabulary Rating Sheet. Next, in column 4, students rate their current knowledge for each word.

Vocabulary Rating for *The Nature of Science and Metrics*

1 = I don't know it.

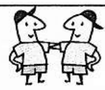
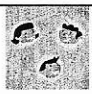
2 = I think I know it.

3 = I know it and can use it.

Tool Word	Rating BEFORE learning	Using the word	Rating AFTER practice
length		The length of my book is the _________ side.	
width		The width of my book is ________ centimeters.	
height		The height of the lab table is _________ centimeters.	
mass		A ___________ has more mass than a ___________.	
volume		I can use _______________ to measure volume.	
area		I can measure the area of a _____________.	
metric system		With the metric system, I can use a ____________ to measure objects.	
observe		I like observing __________________________.	
hypothesis		When I hypothesize, I try to explain _________ ____.	
prediction		I predict that this year I will ________________ ____.	
procedure		I follow a procedure when I _________________ ____.	
data		I enter data into my _______________ to find the area of the brick.	
conclusion		At the conclusion of the lunch I ______________ ____.	
facts		Scientists study facts about __________________ ____.	
inferences		I inferred that my teacher was ______________ when I saw a substitute in her classroom.	
evidence		The substitute is evidence that my teacher is ____________ today.	
scientific theory		Scientific theories explain ___________________ ____.	

Vocabulary Rating for *The Nature of Science and Metrics* 1 = I don't know it. 2 = I think I know it. 3 = I know it and can use it.			
Tool Word	Rating BEFORE learning	Using the word	Rating AFTER practice
scientific law		______________________ is an example of scientific law.	
scientific processes		Following the scientific processes help us to ____ ______________________________.	
controlled experiment		It is important to follow ____________ in a controlled experiment.	
manipulated variable		In an experiment, if I change the manipulated variable, ______________________________ ______________________________.	
responding variable		In an experiment, I think about the responding variable when I write the ________________ at the end.	

<table>
<tr><td></td><td colspan="4">What it means:</td></tr>
<tr><td colspan="5">Examples of how to use the word:
1.

2.</td></tr>
<tr><td>
kind of word</td><td colspan="4">describes (adjective)   action word (verb)   place - thing - idea (noun)   other</td></tr>
<tr><td>
synonym</td><td></td><td>
antonym</td><td colspan="2"></td></tr>
<tr><td>
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</table>

Attachment A

Unit One: Nature of Science & Metrics – FOSIII-L 2008-2009

Name ______________________

Hour ____________

Tasks needed to complete the essential learning objectives.

Essential Learning Objectives:

1. *Use metric system to make measurements.*
2. *Apply the scientific method.*

Gantt Chart: Goals / Grade			A. Textbook Scavenger Hunt	B. Vocabulary – • Metric Terms • Scientific Process Terms	C. Numbers Make Sense	D. Converting Metrics	E. Metric Quiz	F. Penny Lab Part 1	G. Penny Lab Part 2	H. Candle Demo	I. Science Basics	Matrix Score
Objective #1 See above		Date										
Objective #2 See above		Date										

Big Idea	Essential Objectives	Content Objectives	Tasks	Info	Know-ledge	Know-How	Wisdom	Portfolio Evidence: What will you use to show that you know this is idea?	Matrix Score
Big Idea: Develop skills of measuring, collect and analyze data and to be able to draw conclusions. Also to measure and convert in metrics	*1. Use metric system to make measurements. 2.Apply the scientific method*	Make metric measurements	B, C, E						
		Make metric conversions	D,E						
		Develop a hypothesis	B, F, G,I						
		Develop a clear procedure	G						
		Identify Variables	B,G, I						
		Collect data	F, G,						
		Analyze data	F, G,						
		Draw conclusions and make questions	F, G						
		Distinguish between Fact and Inference	B, H, I						
		Use appropriate lab materials	C,E, F, G						

Unit Planner

Course: Foundations of Science III-ELL **Unit: I**

<table>
<tr><th colspan="2">Theme, Enduring Understandings, & Essential Questions for This Unit</th><th>How Students will Demonstrate Their Understanding</th></tr>
<tr><td colspan="2">Theme: Metrics & the Scientific Method

Essential Questions:
• How do we use our textbook? (previewing, headings, pictures, captions, glossary, etc.)
• How do we use the metric system to make measurements?
• How do we apply the scientific method?</td><td rowspan="2">Summative Assessment:
• Metrics quiz
• End of unit test

Formative Assessments:
• Each content objective is linked to various classroom tasks. Completion and performance of these tasks assesses learning
• Daily bellwork and wrap-up activities</td></tr>
<tr><td>Content Objectives:
Students will be able to
• make metric measurements
• make metric conversions
• develop a hypothesis
• develop a clear procedure
• identify variables
• collect data
• analyze data
• draw conclusions and make questions
• distinguish between fact and inference
• use appropriate lab materials</td><td>Language Objectives:
Language structures, grammar structures, language function words, etc.
Students will be able to
• define concept vocabulary orally and in writing
• use superlatives to compare items in their study of metrics
• apply prefixes to the roots Šmeter, -liter, and Šgram to make metric conversions
• use the following language structure: How many _____ equals ______?
• articulate a hypothesis using the real conditional: If ____, then _____.
• use sequence words and the command form to write a procedure: First, fill a cup of water.</td></tr>
</table>

Key & Concept Vocabulary	Building Background and Connecting to Prior Knowledge Strategies	Strategies / Best Practices Used to Explicitly Teach the Skills & Concepts	Supplementary Materials
• caption • heading • index • glossary • length • width • height • mass • volume • area • metric system • observe • hypothesis • prediction • procedure • data • conclusion • facts • inferences • evidence • scientific theory • scientific law • scientific process • controlled experiment • manipulated variable • responding variable	• Key vocabulary emphasized and explicitly introduced • Preview and scan through metric terms in "Numbers Make Sense." Use Insert Method with students to mark text, then discuss with partner, then class • To introduce writing a procedure, students will first work on "procedure in pictures" task about putting on your shoes • Practice with writing conclusions based on simple statements before we write a conclusion for the penny lab. see pg. 43 in Intro Shining Star workbook	❑ Key concept/vocabulary word study ❑ Reciprocal Reading ❑ Repeated readings ❑ Language Experience Approach ❑ Dictogloss ❑ Think-Pair-Share ❑ Jigsaw ❑ Mix & Match ❑ Picture Gap ❑ Paragraph Gap ❑ Scaffolding ▪ Paraphrasing ▪ Think-alouds ▪ Reinforce contextual definitions ▪ Modeling ❑ Realia ❑ Pictures ❑ Manipulatives ❑ Graphic Organizers	• Science text • pennies • water • eyedroppers • petri dishes • potato • apple corer • almond sliver • scales

Daily Plan

Lessons will be organized following a set daily routine:

- Bellwork (five minutes) –students have a task to begin working on as soon as they enter the classroom. It serves to focus their attention and activate their thinking skills.
- Daily Journaling (five minutes)- students write one sentence reflecting on what we studied in the previous class.
- Active Instruction (forty minutes) –this may include language or content instruction, but it is a lesson designed to reflect course objects.
- Wrap-up (five minutes) –an end of class task to re-focusing students' thoughts and ideas.

<u>Day One</u>

- **Bell Work:** Sharing Around the World *(we will model)*
  1. Find 3-4 pictures that represent your home country, culture, or language.
  2. Share with the class your name, home country, hello in native language, and 3-4 pictures.
  3. Find one other person that you have something in common with and discuss your <u>similarity</u> and then try to determine one <u>difference</u>.

(Have large white paper at the top each country we represent (one per country) – as we discuss we can add student names, language "hello", and pictures)

- **Handout/Task:**
  1. Vocabulary
     - Example term: SCIENCE – draw a picture of what you think science involves – how would we define science? – class discussion/demonstrate
     -
  2. Textbook Scavenger Hunt
     - Focus on layout, importance of bold words in the chapter, pictures/tables/and graphs along with their captions, not read like a fiction book – not always linear, glossary, page numbers, and appendix.

- **Homework:** What is the Metric System? Draw what you think represents the metric system. If possible use words to further explain.

- **Wrap-up:** Connect the 9 dots using 4 straight lines while not picking up the pen.

<u>Day Two</u>

- **Bell Work:** Make two piles of pictures - choose the pictures that represent the Metric System for one pile and those that do not for the second pile.

- **Work on Vocabulary- follow Instructional Protocol for Developing Academic Expressive Vocabulary**
  - Metric Terms *(length, width, height, mass, volume, area)*

- **Homework:** Review Metric vocabulary terms and units

- **Wrap-up:** Country Area – which country has the <u>greatest</u> area? – (provide a map for comparisons). Which country covers the <u>smallest</u> area?

Day Three

- **Bell Work:** Sort the pictures that illustrate and/or the tools used to measure length, area, weight, volume into the four measurement categories. (Have 4 note cards with to place the pictures or tools under)

- **Handout/Task:**
  1. Numbers Make Sense Lab –
     - Explain stations – work on stations

- **Homework:** Review Metric vocabulary

- **Wrap-up:** How many meter sticks would I need to measure out 1 Kilometer? How many meters is equal to 1 kilometer (How many kilometers is equal to 1 meter?)

  ____________ Meters = 1 Kilometer

  1 Meter = _____________ Kilometers

Day Four

- **Bell Work:** Determine the volume of the two objects (regular vs. irregular), label with the correct units. How do you read a graduated cylinder? *(demonstrate)*

- **Task:**
  1. Numbers Make Sense Lab – Finish Measurements

- **Homework:** Review Metric vocabulary and units

- **Wrap-up:** How many Centimeter equal 1 Meter? How many Millimeters equal 1 Centimeters?
  ____________ Centimeters = 1 Meter

  ____________ Millimeters = 1 Centimeter

Day Five

- **Bell Work:** Arrange the prefixes in order using the chart on the board. Place the correct number card under each prefix showing equality. For example you have 1 Meter so you would have 1000 Millimeters…

- **Handout/Task:**
  1. Converting with Metrics
     - Demonstrate and then work on converting.

- **Homework:** Finish converting with Metrics/ Review / **Come to class tomorrow with a question.**

- **Wrap-up:** Hold up the correct unit card you would use to measure the following things: (could do one on one as students complete for assessment)

1. Your height m
2. Your weight kg
3. pencil length cm
4. area of Iowa km^2
5. ant length mm
6. volume of a block cm^3
7. volume of a marble mL

Day 6

- **Bell Work:** Measure the area of the note card. Show your work and write the answer with the correct units on the blank side of the note card. Second, complete the metric conversion on the opposite side of the note card. Pair Share your result with your neighbor and help each other if needed.
- **Task:**
  1. Discuss and demonstrate answers to Numbers Make Sense and Converting Metrics
  2. Review/ Finish up metrics

- **Homework: Metric Quiz Tomorrow** - Review Numbers Make Sense and Converting Metrics

- **Wrap-up:** Answer any questions students bring to class.

Day 7

- **Bell Work:** Sharing with your neighbor one thing you have learned about metrics.

- **Handout/Task:**
  1. Metric Quiz – students move from station to station to measure items.
  2. Penny Lab – Part One: How many drops of water will fit on a penny?
     - Class Discussion of Vocabulary terms: Question, Hypothesis, Procedure, Data, and Conclusion – as we proceed through part one of the inquiry lab.
     - Each group of two will come up with a hypothesis to the question. (They will write down their hypothesis: ***If*** *I drop water drops onto a penny one at a time,* ***then*** *5 drops will fit on the penny)*
     - Each group will conduct the experiment and collect data. Three times *(multiple trials = good science)* – they will write down their results and average.
     - Each group will then conclude if their hypothesis was correct or incorrect. (we could write results on the board for group comparison)

- **Wrap-up:** Class discussion of why the results of each group were not the same. What factors may cause the results to be different?

Day 8

- **Bell Work:** Putting on your shoes Procedure in Pictures (*from Targeting Text*)

- **Handout/Task:**
  1. Intro Penny Lab Part 2: Compare the 4 penny surfaces at your desk – How are they different? How are they alike? *(Students are identifying variables that could affect the number of water drops the penny will hold)*

2. Penny Lab Part 2
    - Student groups will identify a variable they would like to test. *(may have to assign based on what they come up with)*
    - Write a hypothesis
    - Write a procedure – showing that they are holding all other variables constant. *(We will demonstrate – as a class)*
    - Test the hypothesis – Collect Data in a Data Table– Multiple trails

- **Wrap-up:** Look at this data set for 3 trials – 5 drops / 4 drops / 12 drops - is this good data – why or why not? What could I do to improve it? Introduce the terms Precision and Accuracy.

Day 9

- **Bell Work:** Look at the graph at your desk – what is it telling you? Notice the important features of a graph – *title, labels, neatness, units ...*

- **Handout/Task:**
    1. Penny Lab Part 2
        - Analyze Data – Make a graph
        - Conclusion

- **Wrap-up:** Share conclusions with the class. *(If variable is determined for class to work together, then we will present various graphs of data looking at other variables to teach how to verbalize a conclusion statement)*

Day 10

- **Bell Work:** What could you do to improve your penny experiment from yesterday? (Looking for: multiple trials, repeat poor data sets, hold other variable constant, allow someone else to repeat the experiment,...)

- **Task:**
    1. Review Scientific Process and Vocabulary – help students define and illustrate terms.
    2. Pair Share Vocabulary illustrations and definitions.

- **Wrap-up:** Pair Share – Group Share: Who uses the scientific process? When do they use it and for what? Do we ever use the scientific process outside of science class?

Day 11

- **Bell Work:** *Something to do with Evidence?? Maybe: (I am from Japan and my parents are Japanese – Do you believe me? Why not?)*

- **Handout/Task:**
    1. Candle Demo – Share/list what they observe using identification cards at their desks. Create two lists and identify them as Fact and Inference. Discuss
    2. Science Basics – Review and reinforcement activity – use textbook to find answers.

- **Homework:** Try to complete Science Basics using textbook

- **Wrap-up:** Discuss first few answers from Science basics.

Day 12

- **Bell Work:** Share with your table peers any questions you may have from Science Basics.

- **Task:**
    1. Discuss Science Basics – Note Format

- **Wrap-up:** Review Metric Conversions

Day 13

- **Bell Work:** Connect the following pictures with the correct word and the correct definition. *Observed, Metric System, Evidence*

- **Task:**
    1. Review
        - Vocabulary illustrations and definitions.
        - Scientific Process
        - Fact/Inference – Providing Good Evidence
        - Metrics

- **Homework:** Study for Unit One Test tomorrow

- **Wrap-up:** Any Questions – Demonstrate test format – circle correct answers, show work, include units, match items, use word bank to fill in the space provided.

Day 14

- **Bell Work:** Shut your eyes, take a few deep breaths, and think back over everything you have done the last three weeks. SMILE ☺

- **Task:**
    1. Unit One Test

- **Wrap-up:** Collect all unit materials

Name ______________________

Textbook Scavenger Hunt

Physical Science - Concepts in Action

Use your science text book to become familiar with the important features it offers you in your learning journey.

What is the text about?

1. Turn to page 4 in your text and answer the following questions:

   a. What is the **title** of this chapter (page1)? ______________________________________

   ____

   b. What is the **heading** of this section? ______________________________________

   ____

   c. What words are in **bold print** on page 4? ______________________________________

   ____

   d. Look at the **image** on this page. Is it important? YES or NO

   e. What do you think this section of the textbook is about? ________________________

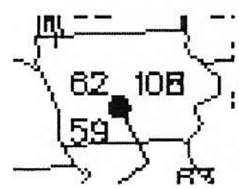
   ____

   ____

Where can I find it?

2. Open your book and look at the **"Contents"** on pages vi-xi. Which chapter and page would I turn to if I wanted to find information about <u>Newton's Laws of Motion?</u>

   Chapter: ______________ **Page Number:** ________________



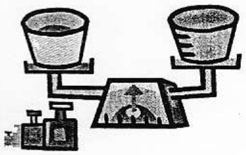
3. Now turn to the **index** on page 939. Find <u>weather map</u> in the index. Which page in the book would help you understand the symbols on this weather map in the picture? ______________________

What does it mean?

4. Turn to the **glossary** on page 905. What is the definition of the word <u>asteroids</u>?

____

____



Numbers Make Sense
-Metric System Practice-

Name______________________

Date ____________ Period ____

In science, it is important to use tools of measurement to collect accurate and precise data. You are going to practice your measuring skills and review the basics of the metric system.

LENGTH

What tools do you use to measure length / distance? ______________________________

List the base metric unit used to measure length.______________________________

Precisely measure the length of...

1. The textbook _____ cm
2. The pencil _____ cm
4. The height of the lab table _____ cm
5. The height of the door _____ m

AREA

What does area measure? ______________________________

What formula do you need to find area? ____________ X ____________ = AREA

List the base metric unit used to measure area. ______________________________

SHOW YOUR WORK: 5cm X 10cm = $50cm^2$

1. This piece of paper ____________ X ____________ = ________ cm^2

2. The top of your lab table ____________ X ____________ = ________ cm^2

VOLUME

What is volume? ______________________________

____

What formula do you use to find the volume of a box which is a regular object?

________________ X ________________ X ________________ = VOLUME

List the base metric unit used to measure volume of a regular object.______________

SHOW YOUR WORK: 2m X 2m X 2m = $8m^3$

1. Your textbook _________ X _________ X _________ = __________ cm^3

2. The brick ________ X ________ X ________ = ________ cm^3

What tool can you use to find the volume of an object that is **not regular** but is irregular?

____

List the base units used to measure volume of an irregular object: ____________

SHOW YOUR WORK: 12mL - 8mL = 4mL

1. Ten pennies ________ - ________ = ________ mL

2. Two Marbles ________ - ________ = ________ mL

MASS

What is mass? ______________________________

What tools measures mass? ______________________________

List the base metric unit used to measure mass. ____________________

Use an **electronic balance** to measure the mass of...

1. The wooden block ________ g   2. The pencil ________ g

Use a **triple beam balance** to measure the mass of...

3. The Copper bar ________ g   4. Calculator ________ g

Metric Notes: Class Discussion

Why do we use metrics in science?

- ➢ ______________________________
- ➢ ______________________________
- ➢ ______________________________

Scientists use the SI metric system for measuring units.

SI = ____________________

What are the three main base units in the metric system?

1. ______________________________

2. ____

3. ____

We abbreviate the units of the metric system. Meter = m, Liter = L, and Gram = g. List the abbreviated metric units for length from largest to smallest:

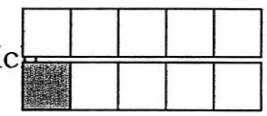
kilometer = __________ **decimeter =** __________

hectometer = __________ **centimeter =** __________

decameter = __________ **millimeter =** __________

Converting with Metrics!!!
Metrics are based on 10 so it is very easy to compare one unit to the next. See the illustration below.

This is equal to **1 mm** which is equal to **0.1 cm**

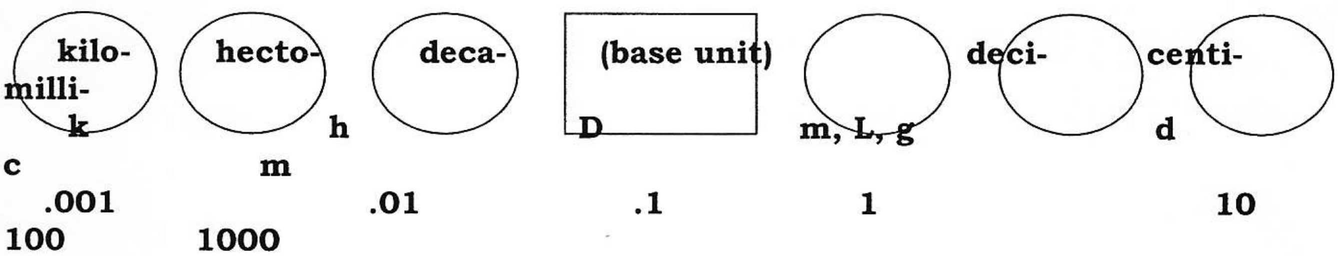


This picture represents **1 cm** which is equal to **10 mm**

1 meter (m) equals ______________ centimeters (cm)

1000 grams (g) equals ____________ kilogram (kg)

Below is the conversion chart showing the prefixes of the metric units and their abbreviations.



Example 1: 8.7 kg (kilograms) = ______________________ g (grams)

8.7 kg = 87 hg = 870 Dg = 8700 g (move the decimal → 3 spaces)
1 2 3

Example 2: 359 L (liters) = ______________________ kL (kiloliters)
(Move the decimal ← 3 spaces)

Example 3: 3 cm (centimeters) = ______________________ Dm (decameters)
(Move the decimal ← 3 spaces)

Let's Practice! Complete the following conversion problems.

1) 45 kg = ________ g

2) 624 g = ________ kg

3) 0.6 L = ________ mL

4) 78.1 m = ________ km

5) 392 g = ________ Dg

6) 42 km = ________ cm

7) 8 L = ________ mL

8) 46.9 cm = ________ m

Metric Practical!

Name ____________________

Show ALL of your work and LABEL each answer with the correct units.

Measure the length of each object to the nearest tenth.

Block ________________ Wooden stick ________________

Measure the area of each object to the nearest tenth.

Paper "A" ________________

Paper "B" ________________

Measure the volume of each object and label the appropriate units.

Wood Block ________________

10 buttons ________________

Measure the mass of each object to the nearest tenth.

A. Triple Beam: ________________ B. Digital Scale: ________________

Conversions	**K**	**H**	**D**	**"Base"**	**d**	**c**	**m**

1. 52.6mL = __________ L **K H D "Base" d c m**
2. 0.34km = __________ dm **K H D "Base" d c m**
3. 2400mg = __________ hg **K H D "Base" d c m**
4. 0.00043kg = __________ cg **K H D "Base" d c m**

Write a Procedure

Steps

Write the steps in the correct order. Begin with a **sequence word** like *first, second, third, next, then* or *finally*. Then, use a **command** to tell the reader what to do.

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

Diagram

Procedure in Pictures

Putting on your shoes

You need:

What to do:

1.

2.

3.

4.

5.

Potato Candle Demonstration

Foundations of Science III

Objective: The students will understand the difference between fact and inferences. They will also understand that in science it is important to gather as many facts as you can before drawing any conclusions. This activity will be following by "What's the Story:" an activity that will continue to work on their observation skills.

Procedure:

Behind the Scenes:

1. Take a medium-sized potato and core it. This may be done either with an apple peeler or an apple corer. This will be your "candle." Place the candle in a beaker full of sand. The candle should stand upright.
2. Cut almond slivers lengthwise to look like a "wick."
3. Using a knife, cut an "X" onto the top of your candle. Do not cut very deep. Place the wick in the center of the X. It should stay upright. Practice lighting the candle once before going before the class.

In Class:

1. When you are ready for the activity, light the candle behind the desk so the students are not able to see. The candle may be difficult to light and you don't want to give it away.
2. Place the lit candle in front of the class. Ask the class to practice their observing skill and give as many observations as possible. Record their observations into 2 separate categories: inferences and facts. Do not inform the students how you are classifying their answers.
3. Ask the students if they see a pattern in how the answers are divided. Define an "inference" as "

a. The act or process of deriving logical conclusions from premises known or assumed to be true. b. act of reasoning from factual knowledge or evidence.

Basically, it is something that you believe to be true.

A fact is something that you know to be true. In science it is important to know all the "facts" about what you are studying.

4. Ask the students how many of you are sure that it is a candle and that should be put into the "fact" category. After they are certain that they are correct, pick up the candle, and bit it! It wasn't a candle after all!!

Name: _______________

"How Many Drops of Water Fit on a Penny?"

Part 1: Penny Lab

Objective: Students will use the scientific method for scientific inquiry.

Question: How many drops of water can fit on the surface of a penny before it runs off the edge?

Materials Needed:

- Pennies,
- Water,
- Eyedroppers,
- Small container/dish

Procedure:

1. Gather the materials listed above.
2. Form a hypothesis for the question.

Hypothesis:

If I drop water drops onto a penny, then ________ drops will fit on the penny.

3. Put the penny in a shallow container.
4. Using the eyedropper provided; add drops of water to the side of the penny facing up.
5. Count the number of drops until the water runs off the penny.
6. Record the number of drops in a data table.
7. Dry the penny and repeat two more times.
8. Write a conclusion to compare the data and the hypothesis.

Data Table:

	Trial 1	Trial 2	Trial 3
Number of Water Drops			

Conclusion:

My hypothesis was _________________. The surface of the penny held _________ drops of water.

Part 2: Penny Lab

Test Variable: ____

Question: ____

____

Materials Needed:

- ____________________
- ____________________
- ____________________
- ____________________

Hypothesis:

If ____, then

____.

Procedure: *(complete procedure writing sheet)*

Data Table:

Number of Drops	Trial 1	Trial 2	Trial 3
Experimental Variable			
Control			

Analyze Data (Graph): Title: ________________________________

Number
Of Drops

__________ __________

Conclusion:
My hypothesis was if ________________________________, then

____

__________.

The surface of the penny

____

____.

Outline of Unit 1 Exam

I. The Metric System
   a. Measurements- students will measure two items on lab table.
   b. Conversions- students will convert measurements from kilograms to grams, etc.

II. The Scientific Process
   a. Hypothesis- given a simplistic, sample idea, students will write a hypothesis using the language structure: *If* ______, *then* _________.
   b. Procedure- students will place in order a set of pictures to explain a sample procedure. Then, students will write the procedure using words of sequence and commands.
   c. Variables- given a sample experiment explained through pictures and simple text, students will identify the manipulated and responding variables from a given set.

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Attachment 3: *Journaling Assignment*

FOSIII L

Name ______________________ Week of ______________________

Daily Journal: What did we do yesterday?

Day 1 ☐	
Day 2 ☐	
Day 3 ☐	
Day 4 ☐	
Day 5 ☐	

Conclusion:
This week, we studied

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