INQUIRY EXPERIENCES AND THE DEVELOPMENT OF SCIENCE VOCABULARY AND CONCEPTS WITH ENGLISH LANGUAGE LEARNERS (ELLS)

by

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Chapter 1

Introduction and Theoretical Basis

Understanding scientific concepts has been a challenge for students for many years. Although there are several theories about the source of this challenge, leading research has proposed that students struggle because they lack the academic science language to help facilitate learning (Rice, Pappamihiel, & Lake, 2004). This perspective has led to the belief that developing scientific *Discourse* is essential for all students to communicate and understand science (Gee, 2004). Traditionally the term *discourse* is used to describe the written or spoken extended expression of thought on a subject (discourse, 2009). However, Gee (2004) uses Discourse with a capital D to describe the language of any distinctive culture or community of practice. Each community, e.g. biology, psychology or history, uses its own Discourse to express its ideas in oral and written exchanges. Science students are exposed to scientific Discourse throughout their education. Therefore, researchers believe that the acquisition of academic science language supports development of scientific Discourse (Gee, 2004; Scarcella, 2003).

In the United States, English Language Learners (ELLs) are even more challenged than native English speakers, because ELLs often lack the academic science Discourse. Although ELLs are often proficient in everyday talk they must gain proficiency in the language of the classroom (Bailey, Butler, LaFramenta, & Ong, 2004). ELLs may find content more challenging because their language proficiency levels do not match the demands of the academic language of the classroom (Bailey & Butler, 2003). Gee (2004;

2008) believes that learning classroom science demands students to use oral and printed language that represent the practices of the scientific community, and that higher levels of success in school require similar language demands. Therefore, students are expected to develop more advanced academic language proficiency for success in science classrooms. In addition, Cummins (1996; 2000) defined academic language proficiency as the extent to which an individual has command of the oral and written academic registers of schooling. However, ELLs lack the academic language proficiency, register shiftting ability and grammatical competence to succeed in the classroom (Freeman & Freeman, 2009). In one of the most recent discussions about academic language proficiency, Scarcella (as cited in Freeman & Freeman, 2009; Scarcella, 2003) referred to grammatical competence or the linguistic dimension of academic language. She divides grammatical competence into five components: phonological, lexical, grammmatical, sociolinguistic and discourse (as cited in Freeman & Freeman, 2009; Scarcella, 2003). The lexical component refers to the vocabulary of academic English (Freeman & Freeman, 2009). Lexical components of scientific Discourse is the focus of this research project. In this research project, the lexical component refers to the development of academic science vocabulary; a components of academic science language proficiency that contribute to the development of scientific Discourse.

Science education research supports the use of writing activities as a tool to facilitate academic science language development and to increase conceptual understanding of science. Researchers believe that written language is more formal and dense in academic language (Bailey, Butler, LaFramenta, & Ong, 2004). When students write, they tend to elaborate with more detail and descriptors in their writing, especially when there are multiple drafts of the writing (Huang, 2004). Therefore, students have a tendency to use more academic science language in their writing, and develop more academic science vocabulary. Researchers also believe that writing is a way of promoting metacognition and developing scientific thinking (Baker et al., 2008; Baxter, Bass, & Glaser, 2000). Overall, researchers believe that writing can contribute to science learning (Keys, 2000). Therefore, students should have the opportunity to write about science as a way of learning science.

Definition of Terms

Everyday Language

Everyday language is also a social language, but one used in casual conversation (Gee, 2004; Merino & Hammond, 2002). Brown and Spang (2007) describe everyday language as vernacular language. For the purpose of this research the term *everyday language* refers to conversational language.

Academic Language

There are several definitions of *academic language*. Gee (2004) defined academic language as a family of social languages. This academic social language enables the user to enact a particular socially situated identity and carry out a particular socially situated activity, therefore the Discourse of a community (Gee, 2004). Academic language is also defined as the language used in the classroom (i.e., textbooks or exams) or other academic contexts for the purpose of acquiring knowledge (Kuehn, 2003; Stevens, Butler, & Castellon-Wellington, 2000). For this study, academic language is the Discourse and language of the classroom.

Academic Science Language

Researchers who studied academic discourse found that academic language in science is content specific and dense, which they refer to as academic science language (Bailey, Butler, LaFramenta, & Ong, 2004; Stevens, Butler, & Castellon-Wellington, 2000). For the purpose of this research, the term *academic science language* is used to describe the oral and written communication used in science classrooms. For example, the Discourse in textbooks, on exams and in the scientific community is science academic language.

Academic Science Vocabulary

Linguists believe that learning academic science language involves learning vocabulary, grammatical structures within written and spoken language, as well as the situation or context of language (Cummins, 2000; Freeman & Freeman, 2009; Scarcella, 2003). Young (2005) believes that teachers should bridge the gap between science vocabulary and students' prior knowledge, and highlights science vocabulary terms to increase conceptual understanding. Examination of science vocabulary development is a component of analysis in the research project. For the purpose of this research the term *academic science vocabulary* is used to describe the science terms or vocabulary of academic science language.

English Language Learners

English Language Learners, formerly known as English as Second Language (ESL) students refer to students whose native language is something other than English (Settlage, Madsen, & Rustad, 2005). English is not the primary language of these students and they are usually taught in monolingual English education systems in the United States (Settlage, Madsen, & Rustad, 2005).

Statement of the Problem

Changing demographics in the USA and across the world have led to science classrooms in which many children bring limited school experience and possess limited knowledge of the English language (Brynes, 2005). While academic language development is critical for all students, supporting the acquisition of this type of Discourse becomes essential for the increasing number of immigrant students (Gee, 2004; Schleppegrell & Colombi, 2002). Statistics suggest that as this population grows, it continues to experience high rates of academic failure: –as of 2002, 44% of immigrant children do not complete high school (Pew Hispanic Center, 2002).

English Language Learners usually must learn literacy skills and science content simultaneously (Merino & Scarcella, 2005; Papai, 2000). Because of this additional challenge, ELLs find it more difficult to use academic science language in expressing their understanding of scientific concepts. Lacking academic science language impedes the ability of ELLs to read and understand scientific Discourse in the classroom and on achievement exams. Learning science and learning a second language involve similar cognitive processes

(Baumgarten & Bacher, 2006). Processes such as observing, seeking information and inferring are some of the cognitive processes shared by both learning science and second language learning. Sharing such processes supports the belief that language learning and conceptual learning must progress together, especially for ELLs in science classes (Bialystok, 2008).

Processing skills involve construction of knowledge; therefore, the constructivist view of science teaching and learning is highly supported (Fathman & Crowther, 2006). Given that the constructivist view of learning requires that the student fit new information together with prior knowledge, the construction of knowledge may be more challenging for ELLs. Language proficiency varies for ELLs in both their native language and new language (Bialystok, 2008; Hakuta, Butler, & Witt, 2000; Snow, 2008). The families of ELLs vary in their educational background which may limit at-home learning. Limited at-home learning reduces prior knowledge and therefore, it is difficult for ELLs to assimilate new and prior knowledge. Lack of assimilation will limit constructivist learning. Given that ELLs bring a range of prior knowledge and language skills into the classroom, there is a need for assessment that accommodates such differences. Currently assessments do not provide feedback about the past or developing knowledge of individual ELLs. An assessment that could provide insight into the emergent science knowledge in ELLs has the potential to provide a researcher or teacher with the ability to identify areas that need more instructional clarification for the individual student.

Objectives

The primary objective of this project was to analyze the change in use of academic science vocabulary and conceptual understanding of erosion by ELLs participating in the Math, Science and Language (MSL) camp conducted in 2008. The researcher examined archival data in the form of student journals collected during the MSL camp. Analysis of the journals provided a representation of the changes in academic science vocabulary that supported the students' development of scientific Discourse and allowed the researcher to trace and measure changes in the participants' conceptual understanding of erosion.

Research Questions

The questions that guided this research were:

1. What type of change in the use of academic science vocabulary occurred over the three-week Math, Science and Language camp of 2008?
2. What type of change in the students' conceptual understanding of erosion occurred over the three-week Math, Science and Language camp of 2008?

Hypothesis

There are two research hypotheses. First, there would be a decrease in the use of everyday vocabulary and an increase in the use of academic vocabulary to describe erosion. Second, there would be an increase in the conceptual understanding of erosion as a result of participating in the MSL camp.

Chapter 2

Review of Literature

One of the goals outlined in both the *National Science Education Standard*s and *Benchmarks for Science Liter*acy is to produce a scientifically literate America (American Association for the Advancement of Science, 1993; National Research Council, 1996). Both documents outline the type of scientific material and the level of science concept understanding that should be achieved at each grade level. Over the years, many states have implemented testing that attempts to measure the level of accomplishment in classrooms. One of the primary challenges faced during instruction and testing is that classrooms often contain ELLs who are struggling with both language development and learning a new topic. These students are held to standards set by governing bodies that were designed for students already proficient in English. Standardized tests are written in complex academic language, ELLs have lower performance on them in academic content areas (Carhill, Suarez-Orozoco, & Paez, 2008; Freeman & Freeman, 2009). These tests require ELLs to assimilate linguistically and culturally to the dominant language. Because standardized tests are so critical to grade-level promotion, classroom learning is even more critical for these students (Buxton, Lee, & Santau, 2008). Currently 51% of ELLs do not complete high school (Carhill, Suarez-Orozoco, & Paez, 2008). To facilitate the reversal of this trend, ELLs will need to develop academic language proficiency and learn to adapt to the academic registers of schooling.

Academic Language Proficiency

One of the major theories about development of language proficiency was conceived by Cummins. He posits that there are two components to language proficiency (Cummins, 1996; 2000). The first component is the ability to carry on conversations about everyday topics, and is referred to as basic interpersonal communicative skills known as BICS. The second is the ability to comprehend, talk, read and write about school subjects, which is referred to as cognitive academic language proficiency known as CALP. In further discussions about language proficiency, Cummins (1996; 2000) suggests that students who develop BICS but not CALP lack the language to succeed in school. BICS develops first because activities that support its development are context-embedded and cognitively undemanding (Baker & Hornberger, 2001; Cummins, 1996; 2000; Freeman & Freeman, 2009). These activities are cognitively undemanding because they are contextualized in everyday social experiences and often involve repetition. On the other hand, CALP is more cognitively demanding for several reasons. The topics in some classes, especially science, are taught context-reduced because the teachers usually lecture without activities to support instruction. The lack of activities provide fewer clues for ELLs to negotiate meaning. In addition, the information is usually new to the students because it is not part of most daily activities and conversations. These context-reduced, cognitively demanding lessons are problematic for ELLs because the language is abstract. As a result of his research, Cummins recommends contextualization of cognitively demanding content to reduce abstraction and allow ELLs the ability to negotiate meaning. Other research support Cummins separation of language proficiency into BICS and CALP components.

Science education researchers, Lee and Fradd (1996) believe that students have the ability to understand science concepts without the language, but are unable to convey precise meaning because the students lack the language. In writing exercises, ELLs who did not develop academic science language lacked the ability to communicate with peers during group discussions and lacked the ability to write about science topics (Merino & Hammond, 2002). These research findings and beliefs support Cummins idea that BICS is acquired first and continues to develop as students acquire CALP. Participants in research conducted by Lee and Fradd (1996) as well as Merino and Hammond (2002) probably had developed BICS but needed further development of CALP. In addition to those researchers, the work of Biber (1992) supports the differentiation between BICS and CALP, though Biber made further distinctions about the difference in language proficiency.

Biber's work focuses on the differences between the syntactic and semantic feature of spoken and written language (Freeman & Freeman, 2009). He described spoken language as interactive, situated and immediate (Freeman & Freeman, 2009). Spoken language is considered interactive because it shows personal involvement. For example, students conducting laboratory experiments, then orally reporting results during experimentation (Freeman & Freeman, 2009). The oral report is interactive and it uses less formal and less precise language during reports. Spoken language is considered situated and more concrete because the actors are named, the time and place are indicated (Freeman & Freeman, 2009). Spoken language is also described as possessing *immediate style*, because most speakers talk about current or recent events (Freeman & Freeman, 2009). Researchers believe that ELLs have fewer difficulties producing texts that are similar to spoken language as compared to written language (Gibbons, 2003). In contrast to spoken language, Biber views written language as edited, abstract and reported (as cited in Freeman & Freeman, 2009). Written language is considered edited because writers spend more time working on the text, they usually use more vocabulary and often produce multiple drafts of material (Freeman & Freeman, 2009). Biber (1992) believes that written text achieves abstraction by using features such as nominalization and passives.

Nominalization is the process of turning a verb into a noun. When nominalizations are used in writing the actor is removed from the sentence and therefore creates abstraction (Freeman & Freeman, 2009). Nominalization creates problems for ELLs because it makes the text difficult to interpret (Halliday & Martin, 1996). Researchers believe that nominalization creates technical words and the use of technical words allow the authors to pack more information into a sentence (Freeman & Freeman, 2009; Halliday & Martin, 1996). Science textbooks are densely packed with language because of nominalization (Unsworth, 1999). In addition to nominalization, abstraction in written language is also created by using passives. In passive sentences the actors are also removed; therefore, creating abstractions and making interpretation difficult.

Biber (as cited in Freeman & Freeman, 2009) labeled written language as reported. Written language is considered reported because written texts are usually about events that occurred in the past or in a different place (Freeman & Freeman, 2009). The written text becomes more formal and structured. If the written text is about a place unfamiliar to the reader, often the reader will not be able to connect to the writing. When the reader cannot make connections, comprehension is reduced. ELLs are expected to read and write using the semantic and syntactic features described by Biber. This task is difficult because ELLs usually develop conversational fluency (BICS) but are less proficient users of academic language proficiency (CALP) (Freeman & Freeman, 2009). The result is the use of conversational language when academic language is more appropriate, therefore ELLs perform lower in academic courses (Freeman & Freeman, 2009)

Further research of textbooks and their structure found that indeed textbooks are dense in academic language (Butler, Bailey, Stevens, & Huang, 2004). In science textbooks, the average percent of academic vocabulary is 14% (Butler, Bailey, Stevens, & Huang, 2004). The topic discussion may take place using only a few paragraphs. When students are developing literacy skills the dense academic science vocabulary in science textbooks contributes to the difficulty student's experience when reading those textbooks. The sentence structure and paragraph length are also unique features of science textbooks and present the reader with challenges. The length of an average paragraph is four sentences and the average sentence is thirteen words long in science texts (Butler, Bailey, Stevens, & Huang, 2004). Butler et al. (2004) compared science to math text and found that the average math text contains paragraphs that are three sentences in length and the average sentence is ten words long. In addition, researchers found that compared to math texts, passages in science text contain a higher number of complex sentences than simple sentences (Butler, Bailey, Stevens, & Huang, 2004). Researchers believe that there are fewer pauses in sentences and paragraphs of science texts, which reduce the ability of the reader to stop and adequately reflect on information (Butler, Bailey, Stevens, & Huang, 2004). These features are also created using nominalization, which make navigating the dense, technical language of science textbooks difficult and laborious to maneuver.

Although academic language is challenging for ELLs, researchers believe that the development of CALP is essential to higher academic performance in school. Despite this belief, there are researchers who believe that the challenge is not in acquiring CALP, but in knowing when to use the appropriate language. Learning to use the appropriate language is an essential component of academic success.

Language Registers

As ELLs assimilate to a new culture and language, they are challenged to understand the context of culture as well as the context of situation (Freeman & Freeman, 2009). When ELLs are learning the context of culture, the learning may be a matter of understanding appropriate classroom behavior in their new cultural setting. In addition to behavioral adjustments, ELLs find themselves learning a new language and learning when and how to use that new language. This situation is referred to as context of situation. Systemic functional linguists describe a context of situation in terms of three elements. The elements are field, tenor and mode. Together they constitute a language register (Freeman & Freeman, 2009; Gibbons, 2003; Huang & Morgan, 2003). Field is described as the topic that is spoken or written about. Tenor is the relationship between the speaker or writer and the listener or reader. Mode is described as the method of communication which is in either spoken or written language. If any of the three elements changes, the register also changes. The academic register changes as the content area changes. ELLs struggle to make the shift to different academic registers because they are acquiring BICS, CALP, content and culture simultaneously.

ELLs may find themselves in situations both in and outside the classroom that require register changes because of vocabulary terms that are used in multiple content areas and in many contexts. These situations create problems for ELLs that are unable to adjust to changes in academic register. One example is use of the terms *law* and *theory*. Both terms are used in everyday and academic language. In academic science language, laws are general descriptions of observable phenomena and theories are inferred explanations of the observable phenomena (Bloom, 2008; McComas, Almazroa, & Clough, 1998). In everyday language and the academic language of political science, law implies an absolute meaning. A law is something that is written, true and enforced. In everyday language a theory is considered simply an idea. These everyday or non-science meanings transfer into science classrooms and imply that laws are absolute, unchanged and more important than theories (McComas, 2003). Therefore, a proposed hierarchy exists between law and theory. These are examples of terms that have multiple meaning and the meaning depends on the context. Words with multiple meanings tend to be problematic for students especially ELLs when they are learning science and are not able to adjust to the register change (Stevens, Butler, & Castellon-Wellington, 2000). In addition, Lee and Fradd (1996) emphasize that ELLs are more vulnerable to discontinuities when learning academic science language because comparable terms and parallel ways of considering ideas may not exist cross-linguistically. Once again, an ELL may not recognize the register shift and therefore will not understand the meaning of the terms in a different context. In this type of situation, ELLs are adjusting to field changes within academic register. In addition to adjustment to field shift, ELLs are also challenged by shifts in tenor and mode.

As ELLs read textbooks in the classroom, then listen to lectures there is a register shifts. There is a mode shift as students move from the more formal written text to a less formal spoken language. There is a tenor shift because the students move from a writer/reader relationship to a speaker/listener relationship. ELLs are challenged by such shifts because often there are inconsistencies between the language of the textbook and the language of the teacher. As stated earlier, science textbooks contain very complex language due to techniques such as nominalization. Therefore, students experience major register shifts between the languages in the textbook as compared to teacher-talk (Freeman & Freeman, 2009; Halliday & Martin, 1996; Unsworth, 1999).

The language that teachers use in the classroom will impact the development of academic science language. Textbooks and teacher-talk impact the acquisition of academic science language (Bailey & Butler, 2003). Textbooks provide precise language whereas teacher talk is not as precise (Bailey, Butler, LaFramenta, & Ong, 2004). These differences often interfere with the acquisition of academic language and therefore promote misconceptions (McComas, Almazroa, & Clough, 1998). These misconceptions occur because ELLs are not able to adjust to the register change. Researchers such as Cobern (1991), believe that all science students are bilingual because they are learning a complex new language while learning science concepts. He believes that science students must assimilate this new science language into their existing language. Assimilation is difficult when teacher-talk and textbooks are inconsistent. Therefore, Cobern (1991) believes that all students struggle in science classes with the register shift, but most researchers agree that ELLs struggle more. In order to help students overcome register shifts, some teachers more consciously help student develop the academic science language and scientific concepts by beginning their lessons with everyday language then gradually transitioning to academic science language (Brown & Spang, 2007). But, one problem that exists is that teachers are often unprepared for culturally and linguistically diverse classrooms (Buxton, Lee, & Santau, 2008). Many teachers are not familiar with the challenges facing ELLs in the classroom. Teachers do not realize the importance of scaffolding the language for students nor are they aware that inconsistencies between teacher-talk and textbook language reduce the ability of ELLs to learn and understand academic science language (Buxton, Lee, & Santau, 2008; Settlage, Madsen, & Rustad, 2005). Although the development of language is important, learning to understand the meaning of content using linguistic components is critical to the success of ELLs.

Linguistic Dimensions

Linguists believe that to develop meaning from written and spoken language, several skills are required (Gascoigne, 2005; Scarcella, 2003). Scarcella (2003) believes that the linguistic dimension contains five components: phonological, lexical, grammatical, sociolinguistic and discourse. ELLs tend to process language word-for-word instead of focusing on meaning and relations between words (Gascoigne, 2005). It is believed that meaning development would increase if students developed grammatical competence (Freeman & Freeman, 2009; Scarcella, 2003).

The Phonological Component

The phonological component involves the speaker's ability to know the sounds and ways to pronounce words (Scarcella, 2003). It involves knowing stress patterns, pronunciation of consonants and vowels in understanding different forms of words (Freeman & Freeman, 2009; Scarcella, 2003). This component focuses on oral language. ELLs are challenged by this component because often the pronunciation is different from the written form of a word. The inconsistencies between the written form and pronunciation frequently lead to misspelling of words and the development of incorrect meaning of words. For example, terms such as *hole* and *whole* sound similar, but have different meanings. Terms like these confuse students, especially ELLs (Carrier, 2005). These students find it difficult to identify in spoken and written language the correct term and definition used in the classroom. In addition, ELLs often spell words phonetically, sometimes in their native language or in English (Settlage, Madsen, & Rustad, 2005). Phonetic spellings make it difficult for teachers to identify misunderstandings the student may have and therefore to guide the student toward the correct interpretation. The problems ELLs experience are because they lack control of the phonological component of grammatical competence.

The Lexical Component

Developing the ability to use the vocabulary of academic English is part of the lexical component. This component also includes knowledge of the forms and meanings of words that are used across academic disciplines and in everyday situations. For example, most of the language in science textbooks consists of content-specific words with meanings that must be understood by students in order for them to comprehend scientific concepts (Huang & Morgan, 2003; Kinniburgh & Shaw Jr., 2007). Researchers who have examined science textbooks identified three categories of words that dominate the textbooks (Stevens, Butler, & Castellon-Wellington, 2000). One category is high-frequency general words which are words used regularly in everyday contexts such as *grow* or *water*. Another category is non-specialized academic words which are academic words that are used across content areas such as *differentiation* or *characterize*. The final category is specialized content-specific language, which is the conceptual terminology. For example, terms such as *osmosis* and *biodiversity* are in this category (Bailey & Butler, 2003; Stevens, Butler, & Castellon-Wellington, 2000).

Similar classification systems are used by other researchers. Snow (2008) proposes a three tier system. Tier-one is used to describe the high-frequency words, tier-two is used to describe the non-specialized academic words and tier-three is used to describe the specialized academic words (Snow, 2008). This specialized content-specific language (tier-three words) includes academic science language. The language itself presents the reader with other challenges that make understanding science writing in text difficult, especially for ELLs who have not developed the lexical component. Furthermore, classroom assessments and activities demand that students express more precise meaning about scientific concepts. Many researchers believe that acquisition of knowledge skills and learning about the world are inseparable from language development. This emphasizes the importance of learning academic language to increase conceptual understanding (Huang & Morgan, 2003; Lee & Fradd, 1996). These beliefs strengthen the argument for acquiring academic language in science classes.

Although many researchers support the development of the lexical component of linguistic competence, there is debate over the category of words that are most important for development of language proficiency. Some researchers believe that the problem ELLs experience learning scientific concepts and developing language proficiency is not related to the lack of academic language, but rather to misunderstanding the meaning of tier-two (non-specialized academic) words (Snow, 2008). Tier-two words are described as those words that are commonly encountered in academic discourse and are not specific to any academic community (Gee, 2008; Snow, 2008). Words such as *compare, differentiate* and *grow* fall into the tier-two category. These words are used in a variety of contexts with variations in their meaning depending on the context. Researchers believe that ELLs usually develop narrow meanings for tier-two words and do not understand the subtle variation in meaning of such words (Snow, 2008). Their research further indicates that teachers are less likely to clarify the meaning of tier-two words for ELLs. Therefore, misunderstanding tier-two words inhibits learning in science classrooms. However, science students often encounter tier-two words in experimental procedures as well as in textbooks. As students read instructions and conduct experiments they are learning and experiencing the language of tier-two words. Such hands-on experiences increase comprehension of the language. Although tier-two words are used to link ideas in science textbooks that are dense in tier-three (academic science language) words, the students must be able to understand the academic science language and its meaning before they can link ideas or concepts.

The Grammatical Component

The ability to understand grammatical features such as morphemes and syntax associated with English grammar are the focus of the grammatical component (Scarcella, 2003). As stated earlier, science textbooks contain sentences that are more complex and packed with information. It is very difficult for ELLs to relate ideas when they are unfamiliar with English grammar (Freeman & Freeman, 2009; Scarcella, 2003). Researchers suggest that ELLs read in content areas beginning as early as possible in school, because early reading enables ELLs to acquire academic vocabulary and academic sentence structure knowledge (Freeman & Freeman, 2009).

The Sociolinguistic Component

The ability to use language for functions that support development of new cultural etiquettes, reading and writing in different genres are elements of the sociolinguistic component (Freeman & Freeman, 2009). Martin (as cited in Freeman & Freeman, 2009) distinguished between three different types of genres: personal, factual and analytical. Science uses factual and analytical genre (Freeman & Freeman, 2009). An individual would need to develop the ability to make register shifts in order to develop sociolinguistic competence. As stated earlier, most ELLs lack the ability to recognize register shifts, therefore those ELLs lack sociolinguistic competence.

The Discourse Component

The discourse component involves developing the ability to structure communicated ideas in a form appropriate for a specific subject area (Freeman & Freeman, 2009). Knowledge and use of the vocabulary in a particular content area assist in developing the discourse component. As stated earlier, Gee (2004) uses Discourse with a capital D to describe the language of a distinct community. Developing scientific Discourse requires academic science language proficiency. Many ELLs lack the academic science language proficiency to effectively communicate in science classrooms.

Overall, the semantic and syntactic structure of both spoken and written text present challenges to ELLs. In order for ELLs to develop academic language proficiency they must acquire CALP. In addition, ELLs must learn to recognize differences in spoken versus written text and shift between those differences in the classroom. Also, ELLs are in need of developing the ability to shift between academic registers in different content areas. Such shifts especially apply to science content. In written texts, the elevated use of technical words makes science content difficult to understand. Therefore, it is critical for ELLs to develop academic science vocabulary as a component of developing academic science language proficiency.

Teaching ELLs Science

In the past, the dominant approach to teaching ELLs separated language instruction from academic content instruction. This proved to be problematic because not all ELLs have the same language proficiency (Bailey & Butler, 2003). ELLs vary in their facility with everyday English language and academic English language (Rice, Pappamihiel, & Lake, 2004). Since ELLs have varying levels of language proficiency upon arrival in the United States, it is difficult to predict the amount of time required in language intervention programs for ELLs to achieve language proficiency comparable to native English speakers. Some researchers found that conversational language proficiency takes three to five years to develop (Hakuta, Butler, & Witt, 2000). Other researchers believe that it may take some ELLs up to seven years to acquire an academic English language proficiency similar to that of native English speakers (Hakuta, Butler, & Witt, 2000; Stoddart, Pinal, Latzke, & Canaday, 2002). Therefore, ELLs could find themselves learning language skills for several years while losing valuable time not learning academic content. Such findings prompted researchers to propose teaching literacy skills and academic content simultaneously.

Researchers that studied programs that integrate teaching science and literacy skills identified several problems in the classroom (Duran, Dugan, & Rafaela, 1998; Hanson, 2006; Laplante, 1997; Merino & Scarcella, 2005). One problem they found is that teachers often identify themselves as either content specialists or language specialists (Merino & Scarcella, 2005). Therefore, teachers experience difficulties integrating both science content and language into the curriculum and find managing both language and content evaluations difficult (Huang & Morgan, 2003). To support the integration of science and literacy skills, researchers suggested teaching science in context, using hands on experience whenever possible (Carnine & Carnine, 2004; Lemke, 2001; Medina-Jerez, Clark, Medina, & Ramirez-Marin, 2007; Palma & Myer, 1988; Stoddart, Pinal, Latzke, & Canaday, 2002;).

Inquiry-based instruction is considered the most powerful instructional context for the integration of academic content and language development (Stoddart, Pinal, Latzke, & Canaday, 2002). Science teaching that uses hands-on experimentation to provide inquiry-based instruction provides more contextualized science experience. Many researchers believe this technique is more effective (Lemke, 1993). Learning the English language involves learning to speak, read and write in English (Stoddart, Pinal, Latzke, & Canaday, 2002). Inquiry-based instruction provides students with the opportunity to speak, read and write in English. Teachers must be able to provide inquiry-based instruction and scaffold the language (Hanson, 2006; Young, 2005). However, while teachers believe that they are engaging students in inquiry-based experiences, researchers document that rather than providing opportunities for experimentation, they conduct laboratory exercises where they usually have students follow a recipe (Lee, Lewis, Adamson, Maerten-Rivera, & Secada, 2008). Classroom discussions are often teacher-dominated and do not involve students.

Therefore, professional development opportunities are suggested for teachers to increase their content knowledge and teaching skills (Lee, Lewis, Adamson, Maerten-Rivera, & Secada, 2008). Teachers need training that enables them to encourage classroom discussions and create activities that involve thinking and questioning that are components of inquiry-based classroom experiences.

Strategies for Integrating Science and Language

Word Walls

Several researchers encourage the use of "word walls" for introducing language to ELLs (Armon & Morris, 2008; Rice, Pappamihiel, & Lake, 2004; Yocom de Romero, Slater, & DeCristofano, 2006). The use of word walls can make students consciously aware of the proper academic science language associated with an activity. When word walls are used to stimulate group discussions, they can facilitate identification of private or personal meanings held by students (Dawes, 2004). Once the private meanings are identified, the teacher will be able to work toward developing a common understanding of the terms for all class members (Dawes, 2004).

Group Work

Incorporating group work using both native and non-native English speakers will assist language development for ELLs (Kim & McKinney, 2007; Medina-Jerez, Clark, Medina, & Ramirez-Marin, 2007; Rice, Pappamihiel, & Lake, 2004; Yocom de Romero, Slater, & DeCristofano, 2006). These activities provide students with time to consider an idea prior to sharing it with others and it increases opportunities for students to listen and speak the language. The teacher must be able to scaffold the language and teach students talk and discussion skills (Dawes, 2004). The think-pair-share is an example of a group activity that is believed to increase science content knowledge and academic science language development, because students learn new uses for familiar words and definitions of new words. In addition, open discussions expose students to new perspectives and ideas about concepts and help clarify misconceptions.

Scaffolding

Teachers must be able to provide oral and written language activities to assist in scaffolding the academic science language and concepts for students (Merino & Scarcella, 2005). Furthermore, they can assist students in making connections between their prior knowledge and new information (Young, 2005). Therefore, the students are socially constructing science concepts with their peers (Duran, Dugan, & Rafaela, 1998; Laplante, 1997). Continued teacher training, through professional development, will assist teachers in scaffolding the concepts and language for ELLs. This is needed because science textbooks inadequately scaffold for these students (Merino & Scarcella, 2005).

Engaging Language

Oral Language

Oral activities such as think-pair-share or group discussion assist teachers in introducing students to the way scientists speak, think and behave. These oral activities increase the students' ability to hear and speak academic science language. The teacher familiarizes the students with the world of scientists so students begin to speak in a scientific genre (Bricker, 2007; Grimberg & Hand, 2009). When students learn academic science language and become more comfortable speaking scientific genre and Discourse, they will also make more meaning with the science language (Grimberg & Hand, 2009; Lemke, 1994). Once the students make more meaning with the academic science language, their conceptual understanding of the science topics will increase. In addition to oral activities, researchers found that written science activities are beneficial in science classrooms.

Written Language

Many teachers believe that it is difficult to incorporate written language activities into the curriculum (Baker et al., 2008). Yet, they do so by including written activities such as concept mapping and science notebook or journal writing. While *journals* and *science notebooks* are generally used interchangeably, some researchers consider journals and science notebooks to have different functions (Hargrove & Nesbit, 2003). Science notebooks require more formal writing and include the type of items found in the scientific writings of researcher scientists. Science notebooks include items such as data sheets, experiment observations and graphs or tables (Hargrove & Nesbit, 2003). On the other hand, journals are slightly different. A journal, although it may share some of the same characteristics as a science notebook, is more informal (Hargrove & Nesbit, 2003). In a journal, students write about their activities of the day or their interpretations of the lessons, they list their questions or write ideas. The students do not adhere to a particular format. The students are allowed to write and create freely about their class experiences (Shepardson & Britsch, 1997, 2004; Yocom de Romero, Slater, & DeCristofano, 2006). For this reason, some researchers believe that journals reflect the students real understanding. Regardless of the type of writing, there are several benefits to using written science activities.

Keeping a science notebook or science journal is considered most beneficial because researchers believe that writing encourages students to think and write about their science activities (Ruiz-Primo, Li, Ayala, & Shavelson, 2004). Armon and Morris (2008) said it best when they quoted Vygotsky, "science writing is more than a record of procedures and facts; it is a tool for developing and articulating thinking" (p. 49). Similar to oral language benefits, writing allows students to construct knowledge in the classroom (Yore, Hand, & Prain, 1999). When teachers respond to student writing in their science notebooks or journals, their responses provide feedback that scaffold the language and improve the students' communication skills (Jablon, 2006). Teachers written feedback is found to greatly influence elementary students because they have less prior knowledge to integrate with new information (Baxter, Bass, & Glaser, 2000; Ivanic, 2004). Upper grade students, on the other hand, are thought to have more difficulty integrating the new information with the old because they possess more prior knowledge and have used that knowledge for a longer time period (Carhill, Suarez-Orozoco, & Paez, 2008). Writing is very beneficial to students when the task is combined with peer discussions (Kulikowich, Mason, & Brown, 2008). Oral language discussions provide students with the opportunity to hear and speak the language. Writing the language provides the students with the ability to record and return to that information for reflection. Again, when the teacher connects the oral and written activity to the idea of behaving as a scientist, researchers found that retention of science knowledge increases over time (Baker, et al., 2008; Bricker, 2007; Hand, Hohenshell, & Prain, 2007; Kulikowich, Mason, & Brown, 2008; Yore, Hand, & Prain, 2000).

Because the benefit of writing has been recognized, an emphasis has been placed on using writing as a way of thinking instead of documenting information (Baxter, Bass, &

Glaser, 2000). Keys (1999) developed the Science Writing Heuristic (SWH) as a tool teachers can use to increase metacognition during scientific writing. Researchers believe there are four major cognitive hypotheses of learning through writing: point of utterance, forward search, genre effects and backward search (Keys, 2000). The point of utterance is described as the time when writers spontaneously write and generate knowledge. The forward search is when writers compare their current drafts to older drafts to identify contradictions and make new inferences. The genre effect is when writers elaborate using the content language. Finally, the backward search is when the writer reflects on what is written, sets new writing goals and generates new content. The SWH takes advantage of these cognitive events by emphasizing the use of prompts to promote more metacognition and therefore enable students to learn and generate new ideas (Hand, Wallace, & Yang, 2004; Keys, 1999;2000; Prain, 2006). Researchers such as Akkus, Gunel and Hand (2007) found the SWH to be advantageous for students when combined with collaborative classroom activities. Hapgood and Palinesar (2007) also promoted the use of the Science Writing Heuristic (SWH) to help teachers and students use writing to promote collaborative thinking and reasoning.

Researchers recommend that students have multiple opportunities to write, such as keeping a science notebook or journal to increase science learning (Huang, 2004; Merino & Hammond, 2002; Ruiz-Primo, Li, Ayala, & Shavelson, 2004; Yocom de Romero, Slater, & DeCristofano, 2006). Others believe that editing drafts of their work is just as beneficial as providing them with multiple writing opportunities (Huang, 2004). Regardless of the writing activity, students learn from writing. But, despite the benefits of oral and written activities, written science knowledge assessments are not as beneficial as the activities.

In summary, strategies for integrating science and language in the classroom assist with development of academic language proficiency. Teaching techniques such as the use of a word wall and group work enable students to develop grammatical competence by including activities that nurture the development of this and the other components of the linguistic dimension of academic language. The use of word walls and group work also enable ELLs to develop the ability to shift between language registers. In addition, the use of continuous oral and written language activities help students develop language register skills. Together grammatical competence and language register skills enable students to develop academic language proficiency, which is critically important in order to understand science content.

Assessing Science Knowledge

While students appear to have the ability to express science concepts without academic language, they are unable to convey precise meaning (Lee & Fradd, 1996). The precise use of academic science language that accurately expresses the meaning of scientific concepts is science knowledge. This science knowledge is developed over time as students continue to study scientific topics. Because the students must learn the language while learning scientific concepts, often during the knowledge development process, the language is misused which creates misconceptions about scientific phenomena. Therefore, students must understand the language and the unique meaning of science language to develop accurate science knowledge.

Researchers assess science knowledge by examining the accuracy of the academic science language students use to express their understanding of scientific concepts. Several tools and techniques are used to assess science knowledge. Some assess oral language through the use of concept maps and grading rubrics. Others evaluate written language using concept maps, performance test and writing exercises such as journaling. The type of assessment the researcher selects depends on the purpose of the research project. The goal of some projects is to analyze both science content as well as language arts skills. A written assessment such as notebook analysis is usually selected for such dual projects. When the researcher is assessing content, a combination of oral and written language assessments are utilized. There are projects that use multiple written language assessments such as a pre/post-test, as well as journaling when assessing science content knowledge. Again, the goal of the project will assist the researcher in selecting the assessment technique.

Oral Assessments

In general, researchers use two designs to create science knowledge assessments. The first design uses student discussions as a vehicle to expose their knowledge of science. The researcher constructs a list of content specific academic science language terms; these are described as key term list (Barone & Taylor, 2007). A checklist of key terms is assembled, and as students participate in discussions, the researcher listens for key terms and notes their use on the checklist. This type of assessment measures the use of academic science language but not the students' conceptual understanding of the topic. Other research designs use question-response sessions to assess scientific knowledge. The researcher assembles a list of questions about a science topic. These questions guide the conversation. Again, correct response is noted by the use of correct science academic language. Both research designs assume that when students use the academic science language that they fully understand the topic, but that may not be the case.

Robinson (1999) described the use of concept maps to score oral language in science. In this study researchers construct concept maps based on key terms spoken by the students during discussions. The concept maps are scored based on the strength of the connection between nodes that represent student ideas. The strength of the connection is indicated by the length of the line drawn between nodes. The shorter lines indicate strong connections between nodes on the concept map. The concept map can assess both language and science conceptual understanding. But, in this case, the concept map is constructed by the researcher. The map is subject to bias or researcher misinterpretation of the students expressed meaning during the discussion and therefore could be inaccurate. Student constructed maps more accurately represent the students knowledge. Therefore, the researcher could more accurately evaluate science knowledge and identify inaccuracies.

Researchers that use rubrics to assess student discussions, use a three level scale rubric (Montgomery, 2000). The highest level is *excellent*. This level is selected by the evaluator when students use academic science language in their response and exhibit accurate conceptual understanding. *Good* is assigned when less detail and lack of depth occur in their response. The lowest level is *minimal*. The researchers rate student responses as limited when they contain only general information. The rubric rates both language usage and conceptual understanding, but the highest rating is given to responses that contain more language. Therefore the rubric is more a measure of language use and not conceptual understanding.

Some researchers prefer oral language assessment that requires students to respond to questions during question-response sessions. These researchers assemble a list of questions and corresponding answers related to a scientific topic. Students are required to respond to the questions with researcher preselected answers (Barone & Taylor, 2007). In this case answers are either correct or incorrect. This type of assessment permits evaluation of both language and conceptual understanding, but does not recognize science knowledge development. As stated earlier, science knowledge develops over time as students acquire the academic science language and meaning of the key terms in that language. As the meaning develops, then conceptual understanding increases. Neither of the oral assessment techniques accommodate the time required to learn science, nor do they recognize the learning process. They simply punish or reward for language knowledge. For these reasons some researchers prefer to assess science knowledge using written assessments.

Written Assessments

There are numerous writing assessment techniques. One writing assessment tool is the performance evaluation that rates science knowledge by measuring the number of correct answers in response to multiple choice or true/false exam questions. Answers are either correct or incorrect on exams. Performance assessments are widely used because they are considered to be a direct measure of students' competence. The problem with this type of assessment is that the current or developing knowledge is not measured.

Other researchers prefer concept mapping to assess written language. The concept map is student constructed, and the evaluator measures the number of ideas written in node links. The connections between nodes are analyzed for accuracy of connected ideas. Students receive higher ratings for the number of more accurately connected nodes. A research project conducted by Haung and Morgan (2003) measured science knowledge development by comparing multiple student constructed concept maps. The students spent several weeks studying classification of organisms, which is a scientific scheme that groups like species together. Each week the students drew a concept map that demonstrated their understanding of the science classification scheme. The researcher compared the weekly maps and was able to identify areas where students had misconceptions about the classification scheme. With this information the researcher is able to measure the students developing science knowledge about the topic. This information allowed the researcher to identify areas that needed clarification for the students and therefore assist in their knowledge development about the topic. Analyzing concept maps is time consuming, but they provide written evidence of the student's knowledge and allow easy identification of areas of instruction that need clarifying.

Still there are researchers who prefer the use of annotated drawings. The drawings are student constructed and they depict an image (usually a drawing) of the relationship between ideas about a topic. The image is labeled using science academic language appropriate for that topic. The drawing is scored similar to the concept map. The researchers who prefer the annotated drawings believe that the drawings provide more evidence of understanding because the students are free to create the drawings and express more ideas in their drawings (Bannister & Atkinson, 1998). The researchers who prefer the annotated drawings believe that the students' creativity is restricted because they focus on connecting nodes (Bannister & Atkinson, 1998). This technique will assess both language and conceptual understanding associated with science knowledge, because there are drawings as well as labels. The annotated drawing analysis is also time-consuming but the students are able to draw their representation of their science knowledge without guidance. Unless there are multiple drawings for the researcher, they will not recognize knowledge development in the students. Transition points in the students' knowledge will not be evident.

Extensive writing assignments include essay writing, journaling or maintaining a science notebook. Researchers use several criteria to assess essays. Some researchers score essays for their structure. The researcher rate the essay based on the ability of the writer to construct an introduction, body and conclusion (Kulikowich, Mason, & Brown, 2008). Others rate essays based on the number of correct versus incorrectly spelled words as well as the syntactic and semantic correctness in the context (McMaster & Campbell, 2008). This method is inappropriate for assessing science knowledge. They address neither language development nor conceptual understanding of science knowledge.

Science notebooks are assessed using a rubric that rates the ability of the student to maintain the notebook based on criteria set by researchers (Aschbacher & Alonzo, 2006). The notebook is usually designed to reflect writings of scientists, which tend to be more formal and structured. Both the science content and writing structure are assessed in the science notebook (Aschbacher & Alonzo, 2006; Baxter, Bass, & Glaser, 2000). Therefore, the students are graded on their ability to maintain correctly organized science notebooks. The assumption is that the students understand scientific concepts because their notebook is structurally organized. In reality, neither the language nor the conceptual understanding is assessed. As stated earlier, some researchers believe that journals reflect the students real understanding. Therefore, journaling was chosen as the preferred writing assessment in the study.

To analyze writing assessments, such as the science notebook or journal, the researchers develop a grading rubric. The rubric is similar to the rubrics used for evaluating oral assessments. One of the problems with these assignments is that they are primarily used to assess language not the conceptual understanding that accompanies science knowledge. Another problem is that it is difficult to track changes such as increased understanding that students undergo while developing their science knowledge. As stated earlier, students might use the language but lack understanding of the scientific concepts. Both language and conceptual understanding should be assessed parallel to one another and with equal magnitude. This type of written assessment will provide students with immediate feedback that enable them to make adjusts in their understanding of science concepts and language use.

Developing a New Written Assessment Instrument

The assessment developed for this research project evaluated science learning by assessing both vocabulary and conceptual understanding. This written assessment instrument was inspired by several past science education studies and written grading rubrics used in fifth and sixth grade science classrooms. The first inspiration came from the use of science journals in the classroom. The use of science journals to monitor science concept development and literacy allowed researchers to determine the students understanding of scientific concepts in their own words (Shepardson & Britsch, 1997; Yocom de Romero, Slater, & DeCristofano, 2006). Second was the use of concept maps to analyze conceptual understanding of topics. The connections between propositions used to produce concept maps is the primary measure of conceptual development (Anderson & Huang, 1989; Huang & Morgan, 2003; Robinson, 1999). Propositions are statements of the subject of an argument, discourse or an essential idea (Keys, Hand, Prain, & Collins, 1999; Novak & Canas, 2007; Rye & Rubba, 2002). It may be the content or meaning of a meaningful declarative sentence, or simply an idea (Keys, Hand, Prain, & Collins, 1999; Novak & Canas, 2007; Rye & Rubba, 2002). Propositions are often identical to a clause, but propositions are meaningful assertions (Keys, Hand, Prain, & Collins, 1999). Several researchers analyzed written science activities by examining propositions in the written text (Fowler, 2000; Klein, 2006; Yore, 2000). They believe that they read a true reflection of the students' knowledge through expressed ideas (Klein, 2006; Yore, 2000). Other researchers believe that the writings provide a window on students' emerging conceptions (Aschbacher & Alonzo, 2006). Given that both science journaling and proposition analysis are considered to reflect ideas and understanding, the newly developed analysis instrument involves identifying propositions in student science journals. The propositions are classified by type using descriptors similar to those that describe the type of propositions expressed in concept mapping. In addition to proposition analysis, the new instrument will enable the identification of everyday vocabulary and academic science vocabulary usage.

Although the propositions are identified and rated as either using everyday or academic vocabulary, the propositions are also rated using a rubric for vocabulary use. The rubric for rating vocabulary usage is a blend of two grading rubrics for science writing at the fifth and sixth grade level. One rubric is used by the Utah Education Network (UEN). The UEN rubric grades use of science language and science content in written text. The use of science language is rated as either excellent (consistent appropriate use of science language and terminology), fair (partial appropriate use of language and terminology) and needs improvement (inaccurate use of language and terminology) (Network, 2004). Science content in the UEN rubric is rated as either excellent (accurate; connected to big ideas in science), fair (mostly accurate; connections to big ideas are not clear) and needs improvement (inaccurate; not connected to big ideas in science) (Network, 2004). The other rubric is used by the Douglas County School District (DCSD) in Colorado. DSCD developed the Science Inquiry & Technical Writing Rubric, which contains three levels of achievement: basic (some misuse or confusion of major concepts or ideas), proficient (uses appropriate scientific facts and concepts, as well as uses relevant vocabulary or formulas), and advanced (uses innovative and efficient sources to collect background information pertinent to the investigative question) (District, 2003). The proposed assessment tool takes into account the fact that the science journals are written by ELLs who are in several phases or levels of language development. In addition, the science journals are informal expressions of the ELLs conceptual understanding of science. Neither rubric was considered absolutely appropriate; therefore, the rubric used in this new instrument is a blend of components from both the UEN and DCSD rubrics.

This new assessment tool attempts to accommodate the developing language by rating propositions on three levels. Level 1 is described as *basic*, which is inaccurate use of terms, not connected to big ideas or confusion of concepts. Level 2 is categorized as *emerging*, it is described as mostly accurate use of terms, connections to big ideas are not clear or there are limited understanding of concepts. And finally, level 3 is described as *proficient*, which is accurate use of terms and connected to big ideas or clear understanding of concepts. In addition, propositions are examined for connections. The connected propositions are typed and rated for conceptual understanding (refer to Table 2).

Connected propositions were categorized by means of a system that Keys et al (1999) used to examine the efficacy of the Science Writing Heuristic (SWH). Keys (2000) developed the SWH as a tool for teachers to use to design classroom activities and increase students' metacognition during writing activities. Increased metacognition during writing activities is thought to help increase conceptual understanding and improve use of science vocabulary (Keys, 1999; 2000). In research conducted by Keys et al (1999), written texts were parsed into clauses. Clauses were described as the primary unit of discourse as defined by Halliday (as cited in Keys et al, 1999). Then clauses were coded according to the type of expansion or meaningful connection to other clauses in a sentence. Expansion includes three types. The first type is elaborations, which is described as further defining or clarifying an idea. An extension is the second type of expansion, which is described as joining two unique but related ideas (Keys, Hand, Prain, & Collins, 1999). And finally enhancement, which is qualifying with further information such as time, place, cause, or condition (Keys, Hand, Prain, & Collins, 1999). The proposed written assessment tool is slightly different. As stated earlier, propositions are identified instead of clauses in the new procedure. Then propositions are coded for type of expansion. The new procedure then rates the expansions for conceptual understanding using the rubric developed from the UEN and DCSD model. This is the same rubric used to rate individual propositions, using ratings of basic, emerging and proficient.

The researcher/developer of this new assessment tool believes that multistep process will allow teachers or researchers to identify misconceptions in the students' understanding of scientific topics. The process will enable a teacher/researcher to pinpoint academic science vocabulary that might require clarification and identify areas of instruction that may need addressing in order to eliminate misconceptions. For example, the researcher could potentially make classroom recommendations that require implementing new activities that improve knowledge development. Because of the assessment of both language and conceptual understanding, the process could provide a more detailed description of student's knowledge development.

Summary

National standards for scientific literacy require sophisticated knowledge of science material. In order to develop a level of science knowledge to meet national standards, students must develop academic language proficiency. ELLs face difficulties developing academic language proficiency for many reasons. First, ELLs lack the academic science language needed for proficiency in science. Second, developing language proficiency is complex, so complex that many years are required to develop high level language proficiency. Development of language proficiency requires skills such as learning new vocabulary, grammatical skills, social skills and register adjustments to content areas. Without those skills ELLs will have difficulty understand academic spoken and written texts. The time required for skills development vary for each individual student. Teaching techniques have attempted to address the development of skills and content knowledge. But, current assessments have not addressed the transition time required for ELLs to develop academic language proficiency. The newly proposed assessment tool will allow teachers or researchers to monitor changes in vocabulary development that facilitate academic language proficiency in science. This same tool will allow teacher/researcher to monitor changes in conceptual understanding in science. The newly developed assessment has the potential to provide teachers with the ability to correct misconceptions held by ELLs. This new analysis tool is named Journal Analysis System TO and from this point on will be referred to as JASTO.

Chapter 3

Methods

This research project is quantitative and non-experimental. JASTO was used to analyze student science journals. The goal of this project was to determine the type of change in academic science vocabulary and conceptual understanding of erosion during the MSL camp 2008.

Participants

The students who participated were Spanish speakers enrolled in Fort Worth Independent School District (FWISD) Language Center program. During the students' time in the Language Center program, FWISD encourages the students to attend the 3-week summer school (MSL camp) offered by the district. Participation was completely voluntary and participants could withdraw at anytime. There were nine boys and thirteen girls for a total of twenty-two students, ages 9 to 11, who attended the 2008 MSL camp. Language level designation was assigned by FWISD. There were fifteen students assigned a language level of *intermediate* and seven were designated as *advanced*. Students assigned a language level of advanced were required to take the Texas Assessment of Knowledge and Skills (TAKS). The MSL camp curriculum is designed to assist with development of math, science and literacy skills.

Instrument

The analysis instrument was developed by the researcher (refer to literature review for details). The instrument was used to identify and rate written propositions in student journals. Appendix C serves as a detailed guide to analysis procedures (JASTO) and rater training guide. Propositions were analyzed for connections which are described as elaborations. In addition, elaborations were categorized and rated. Reliability of the instrument was established using three raters. The raters were two principal investigators/instructors of the MSL camp and the researcher. The raters analyzed three student journals: one journal from the MSL camp 2007 and the remaining two journals from the MSL camp 2008. The raters spent four months analyzing two written activities from each student. Rater analysis occurred independently, and then results were compared for interrater reliability. The interrater reliability at the beginning of analysis was 83%, near the end of the four month process an interrater reliability of 90% was established using the new instrument.

Research Design

The students participated in thirteen days of instruction in which they gathered evidence of erosion utilizing stream tables and field trips around the schoolyard. Woven within the science instruction was explicit instruction to help with literacy skills and especially academic vocabulary. This research study used archival material (student journals) to answer questions about the use of academic science vocabulary and conceptual understanding of erosion. Throughout the MSL camp students had daily opportunities to journal. The students' names were removed from the journal and replaced with an identification number (refer to appendix A). All journaling activities were recorded by page numbers for activity identification (refer to appendix A). Raters manually or electronically completed an analysis form for each journaling activity (refer to appendix D). JASTO measured use of academic science vocabulary, connected ideas and rated the conceptual understanding of ideas for the topic of erosion.

Procedures

After completion of the camp, journals were scanned into the computer, converted into *pdf* documents and cataloged by student identification number. The researcher analyzed twenty-two student journals. Although the journals contain writings about both math and science activities, only science journaling that included 75% student participation were analyzed (refer to Table 1). Refer to appendix A for a list of all camp activities and percent participation. Data were coded using a multistep process. First, propositions were identified in journal entries, and each proposition was coded for use of either academic vocabulary or everyday vocabulary. For a proposition to be classified as using academic vocabulary, the vocabulary term had to be on the word wall from the MSL camp 2008. The word wall functioned to introduce vocabulary terms to students and to stimulate group discussions about the meaning of the terms. It remained displayed during the entire camp and served as a reminder about the spelling and meaning of terms. Students were also directed to the word wall to stimulate private ideas that could be used in activities such as daily journaling activities and developing their erosion book page. Terms on the word wall were used to connect to the student's native language because of existing cognates. Other terms were added from the FWISD Earth science activities list for the Texas Essential Knowledge and Skills (TEKS) assessment. Both lists of vocabulary terms were combined into an academic science vocabulary list (refer to Table 2).

Table 1

Analyzed Science Activities and Description

Day	Activity	Description
1	KWL	Students were directed to list things that they knew about erosion and the things they wanted to know about erosion. They were redirected near the end of the camp to write the things that they learned about erosion.
1	Erosion Picture (EP)	Each student selected a picture that exhibited erosion and was asked to describe that picture.
5	Gentle Erosion (GE)	Students experimented with stream tables. They used a cup containing water and small holes that simulated slow drips of water. The slow drips of water represented gentle rain and therefore gentle erosion. Students ran several trials using the apparatus and were directed to write in their journals after each trial.
8	Hard Erosion (HE)	Experimentation with stream tables and cups containing water and large holes that simulated fast drips of water. Fast drops of water represented heavy or hard drain. There were several trials and students were directed to journal after each trial.
8	Letter to Stephen (LS)	Students were directed to write a letter to Stephen about the things that had learned about erosion. Stephen is a geologist and son of one of the instructors.
10	Book Draft (BD)	Students began to draft a page about erosion for an end of camp book. They were encouraged to write about anything they knew about erosion or a particular type of erosion. Students were able to use the word wall as a vocabulary guide. This activity continued for five days.
16	Return to Erosion Picture (REP)	The last day of the camp students were directed to select the erosion picture that they wrote about on day 1. They were asked to write a new description of that picture.
16	Final Book Page (FBP)	The final draft of the erosion page that students began on day 10.

Table 2

Academic Science Vocabulary List

Camp Day	Term	Camp Day	Term
1	**research**	5	3 dimensional 3D
1	**evidence**	5	2 dimensional 2D
1	**erosion**	5	improper fraction
2	**table of contents**	5	investigation
2	**model**	5	gully
2	**base**	5	observe
2	in addition	5	hypothesis
3	chart	5	orientation
3	ordinal	5	sediment
3	cognate	5	wedge
3	addition	5	slope
3	**pattern**	6	**process**
3	**line of symmetry**	7	length
3	**table**	7	width
3	fair test	8	characteristic
3	**denominator**	8	features
3	**numerator**	8	label
3	**equal**	8	**presentation**
3	**part**	8	variable
3	whole	8	**diameter**
3	**fraction**	8	data
3	**congruent**		*delta*
4	hole		*deposition*
4	**incline**		*Earth*
4	baseline		*Earth material*
5	**alluvial fan**		*force*

Note: **Bold** terms are cognates. *Italics* terms are from TEKS list

Conceptual understanding was determined by rating propositions and expansions. Each proposition represents an idea; therefore, each proposition was rated for conceptual understanding. When there were connected or expanded ideas, they were coded for conceptual understanding. Both propositions and expansions were coded using the same rating system (refer to Table 3).

Table 3

Conceptual Understanding Rating System

Level	Description	Definition
1	Basic	Inaccurate; not connected to big ideas or confusion of concepts
2	Emerging	Mostly accurate; connections to big ideas are not clear or limited understanding of concepts
3	Proficient	Accurate; connected (about a relationship) to big ideas or clear understanding of concepts

Note: System used to rate propositions and expansions

Collected data were consolidated into an Excel spreadsheet. Information in the spreadsheet included participant identification number, gender, language level, grade level and special education designation. The spreadsheet also included the activity, camp day, proposition number, and the proposition. There were also columns for coding everyday vocabulary, academic vocabulary, proposition rating (prop. rating), proposition type (prop. type), expansion combination, expansion type (expan. type) and expansion rating (expan. rating). The spreadsheet contains columns that indicate the number of academic science words, number of spelling errors, number of word errors and comments. Word errors occur when the writer uses words that are incorrect, such as the use of the word *throw* instead of *through*. Data were further coded and imported into Statistical Package for the Social Sciences (SPSS) for further statistical analysis.

Preparing Data for SPSS

Data in the Excel spreadsheet were recorded with a numeric assignment using the system in Table 4. Each analyzed camp activity was coded and separated into discrete files. Each file was designated by activity name and camp activity day. The propositions and expansions were labeled with the abbreviated name of the activity, proposition or expansion number and the variable analyzed (appendix E). SPSS worksheets were organized into a system that mirrored the excel files. Data from the excel files were merged into the SPSS worksheets where analysis continued.

SPSS Analysis

Data in SPSS were recoded to compensate for missing data. Data were missing because students were absent, or they were demonstrating an experiment to the class or simply did not write as much as others. Once final coding was completed in SPSS, the researcher calculated the total propositions using everyday vocabulary and academic vocabulary for each activity. In addition the total number of expansion and average expansion rating were calculated for each activity. Data were collected for each participant of the activity. The results were displayed in SSPS by activity and variable. For example, listings for the KWL were: EverydaytotalKWL, AcademictotalKWL, AvgKWLrating, KWLexpansionrating and KWLexpexistence.

Table 4

Excel Coding System

Variable	Numeric Assignment	Description
Identification Number	1 to 22	
Gender	1	Boy
	2	Girl
Language Level	1	Intermediate
	2	Advanced
Grade	4	
	5	
Designation	1	Special Education
	2	Non Special Education
Type of Vocabulary	0	Everyday
	1	Academic
Proposition Rating	1	Basic
and	2	Emerging
Expansion Rating	3	Proficient
Proposition Type	1	Default
	2	Description
	3	Cause/Effect
	4	Example
	5	Description and Cause/Effect
	6	Description and Example
	7	Example and Cause/Effect
Expansion Type	0	No Expansion
	1	Yes-Extension
	2	Yes-Elaboration
	3	Yes-Enhancement

Measures

This research used descriptive and inferential statistics to describe the change in the use of academic science vocabulary and development of conceptual understanding of erosion. Analysis was separated into categories based on the assessment procedure. Paired samples t-tests were used to determine significant differences between scores for analyzed activities. General linear models repeated measures test were used to determine the relationship between the KWL, book draft and final book draft. The bivariate correlations were used to compare Pearson's r correlation coefficient of proposition ratings and expansion ratings.

Vocabulary Analysis

The first hypothesis was that there would be a decrease in the use of everyday vocabulary and an increase in the use of academic vocabulary over time when the students described erosion. To address this hypothesis, the frequency of propositions classified as containing everyday vocabulary versus academic vocabulary was determined for the eight analyzed camp activities. Comparisons were made between selected activities. The mean everyday and academic propositions of erosion picture (EP) on day one were compared to the return to erosion picture (REP) on day sixteen using a paired samples t-test. These two activities were compared because they are the same activities, but on different days of the camp. A paired samples t-test was used to compare the mean everyday and academic propositions between gentle erosion (GE) and hard erosion (HE) as well as the K of the KWL to the letter to Stephen (LS). Gentle erosion and hard erosion were compared because they are also similar activities. Both the K of the KWL and the LS were activities that enable the students to express what they knew about erosion using the academic science vocabulary, but they occurred at different times in the camp. Finally, the K was compared to the book draft (BD) and final book page (FBP) using the general linear model repeated measures test. These three activities were compared because they used similar writing exercises and they occurred on three different days of the camp. The K occurred on day one, BD on day ten and FBP on day sixteen, these activities reflect beginning, midpoint and end of camp vocabulary use.

The second hypothesis was that there would be an increase in the conceptual understanding of erosion as a result of participating in the MSL camp. In order to determine truthfulness of this hypothesis, the researcher compared proposition ratings and expansion ratings for different activities.

Proposition Ratings

The average proposition rating was expected to increase during the camp and therefore reflect an increase in conceptual understanding. The average proposition ratings were calculated for selected activities. For reasons described earlier, paired samples t-tests were used to compare the average proposition ratings for EP to REP, GE to HE and K to LS. The general models repeated measures test was used to compare average proposition ratings of K to BD to FBP. Correlations between average proposition ratings were determined using a bivariate correlations test.

Expansions

Since expansions are connected ideas, in this study the ideas are represented by propositions. Although the existence of expansions is not used as a measure of conceptual understanding and is not a research hypothesis, the researcher expected the frequency of expansions to increase over time. Therefore, presence of expansions were tabulated and averaged. Paired samples t-tests were used to compare the average number of expansions for EP to REP, GE to HE and K to LS. The general models repeated measures test was used to compare the average number of expansions for K to BD to FBP.

Expansion Ratings

Expansion rating analysis was used as a measure of conceptual understanding. The researcher expected expansion ratings to increase over time. Therefore, the mean expansion rating scored was calculated. Paired samples t-tests were used to compare the average expansion ratings for EP to REP, GE to HE and K to LS. The general models repeated measures test was used to compare average expansion ratings of K to BD to FBP. Correlations between average expansion ratings were determined using a bivariate correlations test.

Limitations

Since this research was an analysis of archival data, the researcher had no control over selection of participants, any learning events, or duration of camp activities. The camp had 22 participants, and because of the small number of participants the researcher is cautious about making generalizations. The instrument used to analyze the journals is newly developed. This is the first use of the instrument after establishing interrater reliability.

Chapter 4

Results

Descriptive statistics of the mean and standard deviation were collected. Comparison of variables was accomplished using the paired samples t-test. Data analysis indicates that there was no significant change in everyday or academic vocabulary as a result of camp participation. But, data do indicate that students began to write expansions in their journals and in some cases expansion ratings increased.

Everyday and Academic Vocabulary

Tables 5 and 6 present mean scores for everyday and academic vocabulary comparisons between selected activities and everyday and academic vocabulary for day one, day ten and day sixteen, respectively. The mean everyday vocabulary scores comparing EP and REP reveal no significant difference in everyday vocabulary used in each activity, $t(17) = -1.004$, $p = .33$. This indicates that the mean everyday EP ($M = 2.80$) and REP ($M = 3.71$) were not significantly higher on day sixteen of the camp. The comparison of academic vocabulary for EP ($M = 1.94$) and REP ($M = 2.06$) indicate similar results. A paired samples t-test found that there was no significant difference between the mean academic vocabulary of EP and REP, $t(17) = -.265$, $p = .795$. The mean everyday vocabulary scores comparing GE and HE indicate that there is a significant difference between the two activities, $t(18) = 6.67$, $p < .01$. The data indicate that there was more everyday vocabulary used in the GE ($M = 10.611$) than in HE ($M = 3.39$). A paired samples t-test suggests opposite results for the comparison of academic vocabulary for GE and HE. The data indicate that the mean academic vocabulary for GE ($M = 3.78$) and HE ($M = 3.72$) activities were not significantly different, t (18) = .075, p = .94. Therefore no change in academic vocabulary occurred between the activities.

Further comparisons of vocabulary use indicate significant differences in both everyday and academic vocabulary use. A paired samples t-test revealed a significant difference in everyday vocabulary use when comparing KWL and LS, t (19) = -2.622, p < .02. The data indicate that everyday vocabulary for LS (M = 2.58) was higher than for KWL (M = .95). In addition, the comparison of academic vocabulary for KWL and LS shows a significant difference, t (19) = -2.58, p = .02. The results indicate that the academic vocabulary for LS (M = 2.790) was significantly higher than KWL (M = 1.58). A one-way repeated measures ANOVA indicates that there is a significant difference between everyday vocabulary comparison of KWL (M = 1.09), BD (M = 7.86) and FBP (M = 3.24), F (2, 40) = 24.24, p < .001. The same test was used to analyze academic vocabulary across the three activities. The results indicate that there was a significant difference in academic vocabulary for the three activities, F (2, 40) = 27.78, p < .001. The mean academic vocabulary was higher for BD (M= 9.10) as compared to KWL (M = 1.57) and FBP (M = 4.24). Overall results indicate that there was a significant increase in everyday vocabulary use as compared to academic vocabulary among the comparisons.

Table 5

Everyday and Academic Vocabulary Comparisons between Selected Activities

Day	**Activity**	**Mean (SD)**
1	Everyday EP	2.76 (1.82)
16	Everyday REP	3.71 (3.25)
1	Academic EP	1.94 (1.56)
16	Academic REP	2.06 (1.75)
5	Everyday GE	10.61 (4.87)
8	Everyday HE	3.39 (1.91)
5	Academic GE	3.78 (2.86)
8	Academic HE	3.72 (2.63)
1	Everyday KWL	.95 (1.47)
8	Everyday LS	2.58 (2.0)
1	Academic KWL	1.58 (1.39)
8	Academic LS	2.79 (1.90)

Everyday EP and REP, $t\ (17) = -1.004$, $p = .33$; Academic EP and REP, $t\ (17) = -.265$, $p = .795$
Everyday GE and HE, $t\ (18) = 6.67$, $p < .01$; Academic GE and HE, $t\ (18) = .075$, $p = .941$
Everyday KWL and LS, $t\ (19) = -2.622$, $p = .02$; Academic KWL and LS, $t\ (19) = -2.58$, $p = .02$

Table 6

Everyday and Academic Vocabulary Comparison for Day 1, Day 10 and Day 16 Activities

Day	**Activity**	**Mean (SD)**
1	Everyday KWL	1.09 (1.45)
10	Everyday BD	7.86 (5.10)
16	Everyday FBP	3.24 (2.34)
1	Academic KWL	1.57 (1.33)
10	Academic BD	9.10 (5.06)
16	Academic FBP	4.24 (2.19)

Everyday, $F\ (2,40) = 24.24$, $p < .001$; Academic, $F\ (2,40) = 27.78$, $p < .001$

Proposition Rating

Tables 7 and 8 present mean scores for proposition ratings and proposition ratings for day one, day ten and day sixteen activities. The mean proposition rating scores comparing EP and REP reveal that there is a significant difference in ratings between the two activities, $t(13) = -2.71$, $p < .02$. The data show that proposition ratings were significantly higher for REP ($M = 2.70$) than for EP ($M = 2.36$). A paired samples t-test indicates a significant difference in rating scores between GE and HE, $t(18) = -2.52$, $p < .02$. The proposition ratings for HE ($M = 2.90$) were significantly higher than for GE ($M = 2.73$). In addition, the average proposition rating scores comparing KWL and LS indicate a significant difference, $t(15) = -3.97$, $p < .05$. This result indicates that the proposition ratings where higher for LS ($M = 2.80$) as compared to KWL ($M = 2.13$). A one-way repeated measures ANOVA was used to compare the KWL, BD and FBP activities. Results indicate that there was a significant difference in proposition ratings between the three activities, $F(2, 34) = 21.51$, $p < .001$. There were higher ratings for BD ($M = 2.86$) than for FBP ($M = 2.80$) or KWL ($M = 2.05$).

Table 7

Proposition Ratings Comparisons between Selected Activities

Day	**Activity**	**Mean (SD)**
1	EP	2.36 (.41)
16	REP	2.70 (.34)
5	GE	2.73 (.19)
8	HE	2.90 (.18)
1	KWL	2.13 (.68)
8	LS	2.80 (.53)

EP and REP, $t\ (13) = -2.71$, $p < .02$
GE and HE, $t\ (18) = -2.52$, $p < .02$
KWL and LS, $t\ (15) = -3.98$, $p < .05$

Table 8

Proposition Ratings Comparison for Day 1, Day 10 and Day 16 Activities

Day	**Activity**	**Mean (SD)**
1	KWL	2.05 (.69)
10	BD	2.86 (.16)
16	FBP	2.80 (.34)

$F\ (2,34) = 21.51$, $p < .001$

Expansion Frequency

Tables 9 and 10 present the mean expansion frequency comparison between selected activities and expansion frequencies for day one, day ten and day sixteen activities, respectively. A paired samples t-test indicates that there was no significant difference in the mean expansion frequencies comparing EP and REP, $t(13) = -.205$, $p = .84$. This result reveals that the mean expansion frequency did not increase from EP ($M = 2.01$) to REP ($M = 2.23$). The analysis shows that there was no significant difference in the mean expansion frequencies comparing KWL and LS activities, $t(15) = -1.85$, $p = .09$. This indicates that there was no significant change in the number of expansions written for KWL ($M = .87$) or LS ($M = 2.1$). On the other hand, there was a significant difference in mean expansion frequencies comparing GE and HE, $t(18) = -2.72$, $p < .02$. This result reveals that there were more expansions written during GE ($M = 5.28$) than in HE ($M = 3.11$). In addition, a one way repeated ANOVA indicates a significant difference in mean expansion frequency for KWL, BD and FBP, $F(2,34) = 20.82$, $p < .001$. The data revealed that there were significantly more expansions written during BD ($M = 9.39$) than during either KWL ($M = .72$) or FBP ($M = 4.16$). The results suggest that students wrote more during GE and BD than during other activities.

Table 9

Expansion Frequency Comparisons between Selected Activities

Day	Activity	Mean (SD)
1	EP	2.08 (2.25)
16	REP	2.23 (1.42)
5	GE	5.28 (4.35)
8	HE	3.11 (1.71)
1	KWL	.87 (1.12)
8	LS	2.07 (2.25)

EP and REP, $t\ (13) = -.205$, $p = .84$
GE and HE, $t\ (18) = -2.72$, $p < .02$
KWL and LS, $t\ (15) = -1.85$, $p = .09$

Table 10

Expansion Frequencies Comparison for Day 1, Day 10 and Day16 Activities

Day	Activity	Mean (SD)
1	KWL	.72 (1.07)
10	BD	9.39 (5.95)
16	FBP	4.16 (2.73)

$F\ (2, 34) = 20.82$, $p < .001$

Expansion Ratings

Tables 11 and 12 present expansion ratings comparisons between selected activities and expansion ratings comparison for day one, day ten and day sixteen. Changes in conceptual understanding were analyzed by comparing the mean expansion ratings. A paired samples t-test indicated no significant difference in expansion ratings when comparing EP ($M = 1.25$) and REP ($M = 1.30$), $t(13) = -.35$, $p = .73$. Data indicate that there was no significant difference in ratings between KWL ($M = 1.93$) and LS ($M = 1.33$), $t(15) = .83$, $p = .42$. Turning to the comparison of mean expansion ratings of GE ($M = 1.33$) and HE ($M = 1.60$) a significant difference was found between the activities, $t(18) = -3.51$, $p < .01$. In addition, a one-way repeated ANOVA revealed that there is no significant difference in the mean proposition ratings comparing KWL ($M = 1.61$), BD ($M = 1.76$) and FBP ($M = 1.72$), $F(2, 34) = .044$, $p = .96$.

Table 11

Expansion Rating Comparisons between Selected Activities

Day	Activity	Mean (SD)
1	EP	1.25 (.38)
16	REP	1.30 (.29)
5	GE	1.33 (.16)
8	HE	1.56 (.30)
1	KWL	1.93 (2.79)
8	LS	1.33 (.49)
t (15) = .83, p = .42		

EP and REP, t (13) = -.35, p = .73
GE and HE, t (18) = -3.51, p < .01

Table 12

Expansion Rating Comparison for Day 1, Day 10 and Day 16

Day	Activity	Mean (SD)
1	KWL	1.61 (2.64)
10	BD	1.76 (.28)
16	FBP	1.72 (.31)

F (2,34) = .044, p = .96

Correlations

Appendix F presents proposition ratings correlation data. When analyzing the correlation of propositions ratings for the eight camp activities, a bivariate correlations test reveal that there is a significantly strong correlation between LS and HE ($r = .53$, $p = .02$). There is a significantly strong correlation between EP and FBP ($r = .67$, $p = .004$). No other significant correlations were revealed.

Appendix G presents expansion ratings correlation data. A bivariate correlations test indicates five correlations when examining the relationship between expansion ratings. When comparing the relationship between GE and EP, a moderately significant correlation was found ($r = .50$, $p = .05$). The data revealed a significantly strong correlation between BD and HE ($r = .65$, $p = .003$) and between REP and LS ($r = .56$, $p = .04$). Another significantly strong correlation was indicated between BD and FBP ($r = .77$, $p < .01$). On the other hand only a moderately significant correlation was found between BD and REP ($r = .51$, $p < .04$) (refer to appendix G).

Summary

Overall the data indicate that the students did not have a significant change in vocabulary. But, the data indicate that there were several occasions when students exhibit increases in conceptual understanding. That was indicated by the increase in expansions as well as increases in expansion ratings. It could be inferred that the students developed a better understanding of erosion because of participation in the camp, and some expressed their understanding in everyday vocabulary whereas others did so in academic vocabulary.

Chapter 5

Discussion

Vocabulary

The results of this study suggest that there was not a significant decrease in everyday vocabulary over time, and there was not a significant increase in academic vocabulary over time. When comparing EP that occurred on day one and REP that occurred on day sixteen, there was no significant change in everyday or academic vocabulary between the activities. This result was not expected by the researcher and therefore does not support the first research hypothesis. Although the data do not suggest an overall significant change in either vocabulary, the comparison of some activities did indicate significant changes in vocabulary for that analysis. For example, when comparing GE and HE, there was a significant change in everyday vocabulary but not academic vocabulary. Fluctuations in vocabulary occurred continuously throughout the camp, moving from significant to not significant. A significant change in either vocabulary was not revealed until day eight of camp activities. The change in vocabulary may not be an actual vocabulary change, but a reflection of changes in writing activities.

Students in the camp spent more time on literacy beginning on day five with the gentle erosion (GE) activity. From day five until the end of the camp, students had at least one literacy activity which usually included journaling. On day ten the students began their book drafts (BD). The most numerous proposition counts occurred when the students began their book drafts. Because of this increase in writing, there were more propositions which were classified using JASTO. As a result, there appears to be a change in vocabulary during these activities. Further analysis revealed that some students did not show any change in either everyday or academic vocabulary, while others showed increases in either everyday or academic vocabulary. There was such variability in vocabulary change that when the data were combined, the extreme differences cancelled one another which resulted in an overall results of no vocabulary change. These findings are supported by earlier research which indicates that one problem with classrooms containing ELLs is that their language proficiency varies (Bialystok, 2008; Hakuta, Butler, & Witt, 2000; Snow, 2008). Recall that one factor that contributes to the varying language proficiency is the time spent in the United States, especially in the classroom. Because some participants had been in the US for a few months, whereas others had been in the country for years, language proficiencies varied. Although there were differences in vocabulary changes among students, a closer examination of raw data enabled the researcher to identify student triumphs and language proficiency variability.

A profile of two participants of the MSL camp reveals the extreme differences in language proficiency of ELLs. Participant #1 was classified as a special education student. When participant #1 began writing in the journal on day one during the EP activity, there was very little writing. For the EP activity there were only two propositions and each contained everyday vocabulary. By day sixteen of the camp, the participant wrote six propositions during REP, and three of them contained academic vocabulary. Participant #1 went from a proposition rating of emergent to one of proficient. Therefore, there was a vocabulary change and a change in conceptual understanding (conceptual understanding will be discussed later). The first participant went from a proposition of “I see the sea” when describing an erosion picture to “I see the sea and sediment, gully, grass, rocks, sky and sand" on day sixteen for the REP exercise. On the other end of language proficiency there is participant #15. This participant began the camp with high academic vocabulary use and maintained that high level of vocabulary throughout camp participation. On day one participant #15 wrote "picture number 1 show erotion by shaping the sand into dunes" and on day sixteen wrote "sediment came down that's the alluvial plain" in the journal. Although there was a misspelled word, the participant knew the vocabulary and had a proficient conceptual understanding during both writing activities. These are examples of varying language proficiency in ELL classrooms that make it difficult to teach and assess each individual student. As stated earlier, conceptual understanding in this research project is measured by rating propositions and expansions. Although vocabulary change varied, analysis indicates that there were significant changes in conceptual understanding.

Proposition Ratings

Students did not show an increase in conceptual understanding unless they wrote expansions. The more expansions written, the higher the conceptual understanding expressed by the students. Data do indicate a significant increase in conceptual understanding from the beginning to the end of the camp. The comparison of activities reveals that there was a significant difference in conceptual understanding between them. The differences in some cases were accompanied by vocabulary changes and in other cases there was no vocabulary change. For example, the comparison of EP and REP indicated a significant increase in proposition ratings, but there was no change in either everyday or academic vocabulary. On the other hand, the comparison of GE and HE, as well as the comparison of KWL and LS both show increases in conceptual understanding. The GE and HE comparison was coupled with an increase in everyday vocabulary, but KWL to LS was accompanied with a change in academic vocabulary. The three-way comparison of KWL and BD and FBP indicates a significant change in conceptual understanding coupled with changes in both everyday and academic vocabulary. These results support the second research hypothesis, that there would be an increase in conceptual understanding over time. The data may reflect the ability of the students to use the vocabulary that they possess in expressing their science knowledge.

Data indicate that students were more comfortable using everyday vocabulary than academic vocabulary. When student wrote in everyday vocabulary they were just as likely or in some cases more likely to express a stronger understanding of erosion. As stated in the literature review, Cummins (1996; 2000) believes that students develop everyday language (BICS) first then acquire academic language (CALP). The data may be indicating such a change because the language proficiency varied in the camp; therefore the students may be at many different levels of BICS and CALP acquisition. Also past research found that ELLs are sometimes more proficient in everyday talk (Bailey, Butler, LaFramenta, & Ong, 2004). These research findings support this idea. On the other hand there are those who would posit that the students lack the language and therefore lack the ability to express their thoughts with enough meaning (Lee & Fradd, 1996). Results of this research project indicate the opposite. Many students were able to express themselves proficiently using everyday vocabulary.

There are researchers who believe that language is not the problem, that the problems is the inability to switch academic registers. (Freeman & Freeman, 2009; Gibbons, 2003; Huang & Morgan, 2003). If either field, tenor or mode, changes, then the academic register changes. An observation of MSL camp activities reveal that registers are continuously changing. Some days the majority of the lessons were focused on one or two topics, but many days it was the opposite. On many occasions one portion of the day was spent on literacy, another on math and still another on science. Often the switch from one activity to another was quick and may not have allowed ELLs to process the change and make the switch themselves. With varying levels of language proficiency present, there is also the possibility that academic register adjustment abilities also vary. Therefore, the results could reflect the diverse vocabulary and concept development shown by the data. Still other researchers believe that the problem is even more complicated, that the problem is linguistic dimensions. The five components of linguistic dimensions were described by Scarcella (2003). The camp was only thirteen days long; therefore, there was not adequate time to address each dimensional component directly. Again, as a result, changes in vocabulary or language and conceptual understanding may be limited for some students.

Expansion Frequency

Although the mean expansion frequency was not used as a measure of conceptual understanding, nor was there a research hypothesis about the frequency, the researcher was curious about their existence. Earlier, expansions were described as connected ideas and therefore connected propositions in this study. When students had extended opportunities to write most they took advantage of the situation. This was evident on day five when the students wrote about gentle erosion and day ten when they began to compose their book drafts. On both days there were definitely more propositions as well as expansions. Comparisons involving either GE or BD with any of the other activities indicated a significant increase in the mean number of expansion for both activities. Researchers believe that when students write they elaborate with more details and descriptors (Huang, 2004).

This lends support to the current finding because the amount of writing both propositions and expansions increased for both days. Expansions were rated and used as a measure of conceptual understanding.

Expansion Ratings

When analyzing the results of the comparison of expansion ratings for EP and REP, there was no significant difference in the rating scores. Recall that there was no significant difference in vocabulary development, and no significant change in expansion frequency. The only significant difference was found in proposition ratings between the two activities. The lack of change between these activities may not reflect the inability of the students to express their knowledge about erosion; rather, the problem may have been the pictures used in the activity. On several of the pictures the evidence of erosion was so minuscule and vague that the students did not recognize erosion. Many pictures contained several distractors, such as barns, that the students focused more on those than on the landscape for evidence of erosion. On the other hand, some pictures were clear and some students had the ability to recognize the evidence at the beginning of the camp, such as participant #15 that was discussed earlier.

The comparison between expansion ratings of the KWL and LS indicated no significant difference in ratings scores between the activities. Once again, there was no significant difference in vocabulary or expansion frequency between the two activities. The only difference was found in proposition ratings. The KWL was the first day of the camp, this activity required that the students think about what they know about erosion and then record. Further analysis of raw data indicate that the students primarily wrote propositions expressing single ideas. The students who wrote expansions and therefore received an expansion rating for that activity already had a proficient understanding about erosion. While the other students did not understand enough to write the expansions. Such students were able to express single ideas.

Other comparisons did reveal significant differences in expansion ratings. The comparisons of GE and HE showed significant differences in expansion frequency, expansion rating, everyday vocabulary and proposition ratings. During both of these activities the students spent time experimenting and writing. The hands-on inquiry on both days increased conceptual understanding. Several researchers promote the use of hands-on activities to increase conceptual understanding (Hand, Wallace, & Yang, 2004; Palma & Myer, 1988; Settlage, Madsen, & Rustad, 2005). The extended literacy time enabled the students to write more and express their ideas.

Finally, the three-way comparison of KWL and BD and FBP indicated no significant differences in expansion ratings. Earlier the data showed that there were significant differences in expansion frequency, everyday vocabulary, academic vocabulary and propositions ratings. These results are not surprising because the students spent several days working on the book draft (BD) which lead to the final book page (FBP). The differences are probably a result from two factors. First, the students had the opportunity to write and reflect on their writing. Researchers believe that the reflection promotes metacognition which leads to an increase in conceptual understanding (Baker, et al., 2008; Baxter, Bass, & Glaser, 2000). Keys (2000) designed a procedure that teachers can use to help increase metacognition known as the Science Writing Heuristic (SWH). Several researchers have used the SWH to examine development of science knowledge and found the process to be successful at increasing conceptual understanding (Akkus, Gunel, & Hand, 2007; Hand, Wallace, & Yang, 2004; Hand, Hohenshell, & Prain, 2007). In addition to promoting metacognition, some researchers believe that ELLs need the opportunity to produce multiple drafts of the writing so that they can receive feedback about each draft and eventually express themselves better (Hand, Hohenshell, & Prain, 2007; Huang & Morgan, 2003). The book draft to final book page provided these students with that opportunity; therefore, the significant results in all comparisons may be a reflection of these effects.

Correlations

Proposition Ratings

When proposition ratings were compared to one another, only two sets of relationships were significantly correlated. First, data indicate that there was a strong correlation between LS and HE. These two were probably highly correlated because they occurred on the same day, one activity after another. As stated earlier, HE involved experiments and then journaling immediately follow each experiment. The LS activity was journal writing at the close of the day. LS was a summarization of the days events or any other event up to that camp day that they wanted to write about. Therefore, the strong positive correlation was not surprising.

Another strongly correlated pair was the EP and FBP comparison. The strong connection between these activities is probably a reflection high performances on camp activities from students that had strong knowledge about erosion. Examination of raw data indicate that the students who wrote proficient level propositions on day one also did the same on day sixteen. Again, students such as participant #15 had the concepts from the beginning which was shown throughout the camp.

Expansion Ratings

Tests revealed three strong correlations. They were the relationship between BD and HE, REP and LS, and finally BD and FBP. These activities began to occur around the middle of the camp. This is the same time when there were more changes in vocabulary as well as proposition and expansion writing. These changes and relationships may be a result of extended literacy activities. As stated earlier, students had the opportunity to write more and for BD and FBP there were multiple drafts of the written text which have been found to benefit ELLs. In addition, the students were directed to focus on vocabulary of the word wall around day ten of the camp. Although there were both everyday vocabulary and academic vocabulary word walls, students elected to use terms on the word wall that they were more comfortable using. Both the extended literacy opportunity and word wall probably increased the conceptual understanding ratings.

Conclusion

The results of the research project reflected the diversity in academic skills ELLs possess. Each ELL had different language proficiencies which were reflected in the vocabulary analyses. Despite vocabulary challenges ELLs were able to learn more about erosion and express their knowledge in either everyday or academic vocabulary. The proposition ratings and expansion ratings increases were evidence that their conceptual understanding increased but most of their vocabulary did not change. Although the fact that there was in increase in conceptual understanding without academic vocabulary is great, as an educator, my concern is the ability of the students to perform on school exams. Review of literature reveals, that standardized exams are written in the culturally dominant language (ie. English) (Bailey, Butler, LaFramenta, & Ong, 2004; Stevens, Butler, & Castellon-Wellington, 2000). The language is complex and ELLs perform lower on those exams (Bailey, Butler, LaFramenta, & Ong, 2004; Stevens, Butler, & Castellon-Wellington, 2000). Most students in the camp developed a more proficient understanding of erosion, but on standardized exams they would not perform well because they lack the academic vocabulary to support all their other linguistic accomplishments. In order to provide students such as those in the camp with the ability to achieve in the classroom they still need vocabulary development. The JASTO analysis process could enable teachers to provide feedback to the students continuously that would help scaffold the academic vocabulary for the students. Such feedback could provide ELLs with the vocabulary knowledge that would assist their linguistic development and allow them to achieve higher scores on exams and therefor the recognition that they deserve.

Limitations

One of the limitations of the study was the use of the word wall to classify academic vocabulary. There were more academic terms discussed during the camp that did not appear officially on the word wall. Students used terms in their writing that they learned previously. Those terms were not on the word wall and therefore propositions containing them could not be counted as academic because of preset screening criteria in JASTO. A close profile of students using both qualitative and quantitative methods could provide researchers with a better image of the students' abilities. This assessment tool has the potential to do so, but the process needs adjusting. There is also a need to compare written to spoken camp language.

The students possibly expressed their understanding of erosion better verbally. There were several days during the camp curriculum that limited literacy activities or did not provide adequate time for students to complete writing their thoughts. This is very evident when journaling occurred near the end of the day. Students would sometimes leave an incomplete sentence or phrasing that suggests they stopped abruptly to leave for the day.

Future Research

Analysis of journals using JASTO should include those journals from the MSL camp 2007 and 2009. Expanding the analysis to the other camp journals would increase the number and possibly provide an even better picture of changes in vocabulary and conceptual understanding during the camps. In addition, the pictures and math activities should be analyzed to understand the complete change in conceptual understanding as a result of camp participation. As stated earlier, the analysis should go beyond quantitative and extend into qualitative. An analysis of the data using qualitative measures could provide more insight into vocabulary and conceptual understanding of each camp participant. The changes experienced by participant #1 that were discussed earlier would not be identified using just quantitative methods.

Appendix A
MSL Camp 2008
Journal Activities

Day	Activity	% Participation
1	Setup Table of Contents	
	KWL	**87%**
	Select erosion picture and record	**78%**
	Map/model of playground erosion	**74%**
	JE - How do I feel about today's activities?	**13%**
	JE - What new thing did they learn?	**0%**
2	JE - How do authors and illustrators help the reader understand	**91%**
	JE - Today I learned, I wonder, I have a question about	**0%**
3	Journal Response, Free writing or response to KWL	**13%**
	JE - What they know about conducting an experiment in science	**74%**
4	Draw birds' eye and lateral view	**69%**
	Journal Response, Free writing or response to KWL	**22%**
5	Gentle Erosion Trial #1, Draw and journal	**91%**
	Gentle Erosion Trial #2, Draw and journal	**91%**
	Gentle Erosion Trial #3, Draw and journal	**87%**
6	Journal maintenance and Free writing	**43%**
7	Highlight experimentation process- students take notes in journal	**96%**
	Revisit KWL	**0%**
8	Introduction and begin writing workshop	**96%**
	Model writing in journal	**87%**
	Hard Erosion Trial #4, Draw and journal	**78%**
	Hard Erosion Trial #5, Draw and journal	**48%**
	Hard Erosion Trial #6, Draw and journal	**39%**
	Hard Erosion Trial #7, Draw and journal	**35%**
	Hard Erosion Trial #8, Draw and journal	**0%**
	Write a letter to Stephen about observations	**87%**
10	Begin drafts for erosion book	**100%**
11	Continue drafting erosion book	**56%**
12	JE - Design their own experiment	**87%**
	Continue drafting erosion book	**0%**
13	Continue drafting erosion book	**22%**
	Conduct student designed experiment and journal	**56%**
14	Continue drafting erosion book	**8%**
	Conduct student designed experiment and journal	**48%**
15	Complete KWL	**17%**
16	Return erosion picture from day 1 and record	**74%**
	Erosion book page	**100%**

Appendix B
MSL Camp 2008
Analyzed Activities

Day	Activity	Participants																					
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
1	**KWL**	1	1	1	N	1	1	1	2	1	1	2	2	5	1	1	1	1	2	1	1	2	N
1	**Erosion Picture**	2	2	2	N	2	2	1	3	2	2	3	3	N	2	N	2	2	2	1	1	N	N
5	**Gentle Erosion**	10	9	N	2	8	10	11	10	11	11	10	11	6	11	10	6	10	10	11	1	9	7
8	**Hard Erosion**	N	N	18	12	19	N	19	16	17	20	19	18	14	21	19	17	19	21	17	18	N	16
8	**Letter to Stephen**	N	N	20	14	21	15	22	29	20	23	21	21	15	22	21	21	20	23	19	20	21	17
10	**Begin Book Drafts**	23	21	23	16	24	20	25	30	23	26	24	24	18	25	24	24	23	26	22	23	24	20
16	**Return to Erosion Picture**	33	26	33	N	N	29	33	39	N	36	33	30	28	33	N	32	31	36	N	33	33	28
16	**Erosion Book Page**	4	11	18	22	3	6	15	1	7	8	17	19	10	16	5	9	20	2	14	13	21	12

N – No entry

1. On the analysis worksheet write the journal name, page to be analyzed, initials of the rater.
2. Identify a chunk of information and write it on the analysis worksheet.
3. **When writing the chunk on the worksheet, some words signal relationships. These words we refer to as signal words. For example, and, it and because.** Circle signal words on the worksheet or if entering information into the computer highlight the signal word in **yellow**.
4. Identify the propositions, assign a number to the proposition and write it on the spreadsheet.

Propositions may be a statement of the subject of an argument or a discourse or an essential idea. It may be the content or meaning of a meaningful declarative sentence, or simply an idea. A clause expresses a proposition.

For example, this statement contains two propositions.

Erosion makes pebbles and boulders erode.

Proposition 1: Erosion makes pebbles erode

Proposition 2: Erosion makes boulders erode.

- **Propositions that are repeated should not be scored more than once.**
- **Signal words such as "and" should be written in all caps. Ex. AND**
- **Words that are implied should be in brackets. Ex. [sediments]**
- **There may be situations when a word is both implied and a signal word, they should be in all caps and in brackets. Ex. [AND]**

Prop. #	Proposition	E	A	Con.	Prop. Type	Comments
15	BECAUSE the water carry the sediments					Because is a signal word
3	[erosion] happen because the water carry the sand					Erosion was implied in this proposition
20	[AND] water cause erosion					And is a signal word and it is implied

5. Classify the proposition as one using either “everyday” or “academic” language. **This is driven by terms on the wordwall. If at least one word from the wordwall is in the proposition, the proposition is classified as academic.**

   For example:

   “Things cause erosion” is classified as academic because the word erosion is on the wordwall.

   “[be]cause of the force” is classified as everyday because the word force is not on the wordwall.

6. Rate proposition for conceptual understanding. List rating in the column labeled “Con”.

   Rating Scale:

   Level 1 – Basic – Inaccurate; not connected to big ideas or confusion of concepts
   (ex. and island is a alluvial fan)

   Level 2 – Emerging – Mostly accurate; connections to big ideas are not clear or limited understanding of concepts

   (ex. Erosion can happen in hills)

   Level 3 – Proficient – Accurate; connected (about a relationship) to big ideas or clear understand of concepts
   (ex. BECAUSE the water carry the sediments)

   During this stage each proposition must be evaluated independently

7. List the type of proposition in the column labeled “Prop. Type” using this key. Some propositions may be classified in multiple categories.
   - Cause/Effect – **C/E –** (ex. Because water carry the sediments)
   - Examples- **EX**
   - Default (does not fit into any category or cannot be categorized) - **DEFA**
   - Description **– DES -** (ex**.** Wind can made an alluvial fan)

   These are a few examples from preliminary analysis

Prop. #	Proposition	E	A	Con.	Prop. Type	Comments
9	and island is a alluvial fan		√	1	DES	Inaccurate use of academic terms and basic conceptual understanding An island is not an alluvial fan
30	AND IT makes that a river can be made	√		1	DES	Inaccurate use of everyday terms and basic conceptual understanding
13	Wind can made an alluvial fan		√	2	DES	Inaccurate use of terms, but an emerging conceptual understanding because the participant knows that something made and alluvial fan
4	[water] because it make sand mud	√		2	C/E	Mostly accurate use of everyday terms and emerging ideas. Sand does not become mud.
10	Erosion can happen in mountains		√	2	DES	Mostly accurate use of academic terms and emerging conceptual understanding
18	Things cause erosion		√	3	DES	Mostly accurate use of academic terms and a proficient conceptual understanding
31	If the rain is gentle	√		3	C/E/DES	Accurate use of everyday terms and proficient conceptual understanding
32	[gentle rain] the gully will not be very deep		√	3	C/E	Accurate use of academic terms and proficient conceptual understanding
2	[AND] wind is blowing erosion happen		√	2	C/E	Accurate use of academic terms and emerging conceptual understanding

***It is recommended that the rater complete steps 1 – 8 for a chunk before moving to step 9**

8. Determine whether or not the propositions are “Expansions” or a combination of propositions could be an expansion.

Expansions may be

a) ELA - Elaborations – further defining or clarifying and idea – adding details

(ex. Wind causes erosion [AND] water cause erosion)

OR SIMPLY

(This table is brown with black legs)

b) EXT - Extensions – joining two unique but related ideas – connecting different ideas

This example Begins with two propositions that were enhancements and the third position is an extension of the first two.

1st proposition - If there's a lot of water

2nd proposition - [a lot of water] it can make a gully

3rd proposition - AND IT makes that a river can be made **– this is the extension**

OR SIMPLY

(The table is brown and the étagère is brown)

c) ENH - Enhancements – qualifying with further information such as time, place, cause or condition – adding external details to the event

(ex. [a lot of water] it can make a gully)

OR SIMPLY

(This table is brown because they used a dye)

9. List the combination using the proposition number as an expansion and record in the column labeled "Expansion".
For example: 3→2, means that proposition #3 is an expansion of proposition #2.

10. List the type of expansion in the column labeled "Expan. Type" using this key.
ELA - Elaborations
EXT – Extensions
ENH – Enhancements

11. Rate the expansion and record in the column labeled "Expan. Rating"

Level 1 – Basic – Inaccurate; not connected to big ideas or confusion of concepts

Level 2 – Emerging – Mostly accurate; connections to big ideas are not clear or limited understanding of concepts

Level 3 – Proficient – Accurate; connected (about a relationship) to big ideas or clear understand of concepts

During this stage more than one proposition is evaluated

Below are a few examples from preliminary analysis

Prop. #	Proposition	E	A	Con.	Prop. Type	Expansion	Expan. Type	Expan. Rating	Comments
28	If there's a lot of water	√		2	DES/C/E	28→26,27	ENH	3	
29	[a lot of water] it can make a gully		√	3	DES	29→28	ENH	3	
30	AND IT makes that a river can be made	√		1	DES	30→28, 29	EXT	1	We rated the expansion a 1 because we do not know what the "it" references.
5	The wind just carry the sediments place to place		√	1	DES	5→2	ELA	2	Not correct because the wind did not carry the sediments, but in the elaboration the concept is emerging.

12. Indicate the # of academic terms, spelling errors and word usage error for each proposition
    Any comments may be recorded in the column labeled "Comments"

Appendix D
JASTO Analysis Form

Journal:__________ Page_________ Date:____________________ Rater________________

Chunk:____
____
____

Prop. #	Proposition	E	A	Prop. rating	Prop. type	Expan	Expan type	Expan rating	Aca term #	Spell error #	Word error #	Comments

Appendix E
SPSS Variable Naming System

Variable Naming System

Day	Activity	Variable	Variable Name
1	KWL	Type of Vocabulary	KWL#type
		Proposition Type	KWL#proptype
		Proposition Rating	KWL#proprating
		Expansion Type	KWL#expansion
		Expansion Rating	KWL#exprating
1	Erosion Picture	Type of Vocabulary	EP#type
		Proposition Type	EP#proptype
		Proposition Rating	EP#proprating
		Expansion Type	EP#expansion
		Expansion Rating	EP#exprating
5	Gentle Erosion	Type of Vocabulary	GE#type
		Proposition Type	GE#proptype
		Proposition Rating	GE#proprating
		Expansion Type	GE#expansion
		Expansion Rating	GE#exprating
8	Hard Erosion	Type of Vocabulary	HE#type
		Proposition Type	HE#proptype
		Proposition Rating	HE#proprating
		Expansion Type	HE#expansion
		Expansion Rating	HE#exprating
8	Letter to Stephen	Type of Vocabulary	LS#type
		Proposition Type	LS#proptype
		Proposition Rating	LS#proprating
		Expansion Type	LS#expansion
		Expansion Rating	LS#exprating
10	Beginning Erosion Book Draft	Type of Vocabulary	BD#type
		Proposition Type	BD#proptype
		Proposition Rating	BD#proprating
		Expansion Type	BD#expansion
		Expansion Rating	BD#exprating
16	Return to Erosion Picture from day 1	Type of Vocabulary	REP#type
		Proposition Type	REP#proptype
		Proposition Rating	REP#proprating
		Expansion Type	REP#expansion
		Expansion Rating	REP#exprating
16	Final Erosion Book Page	Type of Vocabulary	FBP#type
		Proposition Type	FBP#proptype
		Proposition Rating	FBP#proprating
		Expansion Type	FBP#expansion
		Expansion Rating	FBP#exprating

Appendix F
Proposition Ratings Correlations

		KWL	EP	GE	HE	LS	BD	REP	FBP
KWL	Pearson Correlation	1	.400	.572*	.113	.471	.480*	.144	.140
	Sig. (2-tailed)		.111	.017	.687	.077	.044	.623	.580
	N	18	17	17	15	15	18	14	18
EP	Pearson Correlation	.400	1	.138	-.084	.302	.168	.307	.666**
	Sig. (2-tailed)	.111		.611	.776	.294	.518	.308	.004
	N	17	17	16	14	14	17	13	17
GE	Pearson Correlation	.572*	.138	1	-.124	-.056	.322	-.001	-.091
	Sig. (2-tailed)	.017	.611		.624	.825	.155	.996	.704
	N	17	16	21	18	18	21	16	20
HE	Pearson Correlation	.113	-.084	-.124	1	.529*	.114	-.012	-.022
	Sig. (2-tailed)	.687	.776	.624		.024	.642	.967	.931
	N	15	14	18	19	18	19	14	18
LS	Pearson Correlation	.471	.302	-.056	.529*	1	.280	.493	.126
	Sig. (2-tailed)	.077	.294	.825	.024		.246	.073	.617
	N	15	14	18	18	19	19	14	18
BD	Pearson Correlation	.480*	.168	.322	.114	.280	1	.124	.020
	Sig. (2-tailed)	.044	.518	.155	.642	.246		.636	.933
	N	18	17	21	19	19	22	17	21
REP	Pearson Correlation	.144	.307	-.001	-.012	.493	.124	1	-.078
	Sig. (2-tailed)	.623	.308	.996	.967	.073	.636		.767
	N	14	13	16	14	14	17	17	17
FBP	Pearson Correlation	.140	.666**	-.091	-.022	.126	.020	-.078	1
	Sig. (2-tailed)	.580	.004	.704	.931	.617	.933	.767	
	N	18	17	20	18	18	21	17	21

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Appendix G
Expansions Ratings Correlations

		KWL	EP	GE	HE	LS	BD	REP	FBP
KWL	Pearson Correlation	1	.312	.225	-.344	.017	.072	-.021	-.031
	Sig. (2-tailed)		.222	.386	.209	.952	.777	.944	.902
	N	18	17	17	15	15	18	14	18
EP	Pearson Correlation	.312	1	.496	.050	-.104	-.004	-.029	-.063
	Sig. (2-tailed)	.222		.051	.866	.723	.988	.925	.810
	N	17	17	16	14	14	17	13	17
GE	Pearson Correlation	.225	.496	1	.347	.003	.137	.349	.031
	Sig. (2-tailed)	.386	.051		.158	.991	.553	.185	.896
	N	17	16	21	18	18	21	16	20
HE	Pearson Correlation	-.344	.050	.347	1	.453	.645**	.388	.450
	Sig. (2-tailed)	.209	.866	.158		.059	.003	.171	.061
	N	15	14	18	19	18	19	14	18
LS	Pearson Correlation	.017	-.104	.003	.453	1	.321	.557*	.318
	Sig. (2-tailed)	.952	.723	.991	.059		.180	.039	.199
	N	15	14	18	18	19	19	14	18
BD	Pearson Correlation	.072	-.004	.137	.645**	.321	1	.505*	.771**
	Sig. (2-tailed)	.777	.988	.553	.003	.180		.039	.000
	N	18	17	21	19	19	22	17	21
REP	Pearson Correlation	-.021	-.029	.349	.388	.557*	.505*	1	.471
	Sig. (2-tailed)	.944	.925	.185	.171	.039	.039		.056
	N	14	13	16	14	14	17	17	17
FBP	Pearson Correlation	-.031	-.063	.031	.450	.318	.771**	.471	1
	Sig. (2-tailed)	.902	.810	.896	.061	.199	.000	.056	
	N	18	17	20	18	18	21	17	21

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

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ABSTRACT

INQUIRY EXPERIENCES AND THE DEVELOPMENT OF SCIENCE VOCABULARY AND CONCEPTS WITH ENGLISH LANGUAGE LEARNERS (ELLS)

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The primary objective of this project was to analyze the change in use of academic science vocabulary and conceptual understanding of erosion by the ELLs participating in the Math, Science and Language (MSL) camp conducted in 2008. The researcher examined archival data in the form of student journals collected during the MSL camp of 2008. Current assessments are not developed to assess both vocabulary development and conceptual understanding. The researcher developed a new assessment tool named JASTO that allowed assessment of both vocabulary and conceptual understanding parallel to one another. JASTO was used to analyze the science journals of the MSL camp of 2008. Data indicate an increase in conceptual understanding of the erosion topic. Some students expressed their understanding using everyday vocabulary and others using academic vocabulary. The type of vocabulary usage was dependent on the English language proficiency of the student.