The Effect of Non-Content Vocabulary on the Content Reading Comprehension in a High School Science Classroom

Benjamin G. Fuller
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First Supervisor

Diane Barrett

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The Effect of Non-Content Vocabulary on the Content Reading Comprehension in a High School Science Classroom

By

Benjamin G. Fuller

Submitted in partial fulfillment of the requirements for the degree M.S. Mathematics, Science and Technology Education

Supervised by

Dr. Diane Barrett

School of Arts and Sciences
St. John Fisher College

April 2009
Abstract

It has been noted that students in secondary science, Regents courses tended to struggle with reading comprehension of the Regents questions. The focus of this study was to look at students' struggles with non-content vocabulary as a factor in their issues comprehending content specific readings, with most of the study focused on Regents questions. Factors that contributed to limited lexicon development and reading comprehension such as socioeconomic status, the focus of vocabulary and literacy development within content courses, and appropriateness of reading level of Regents questions to their target audience were a focus of the study. Synthesis of quantitative data along with qualitative data showed promising trends that aligned with the literature focused on life-long development of readers and creating motivation for learning.
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It would only seem logical that with the more words that one knows the more accomplished reader one would be. There has been a great focus in all subjects on vocabulary development to help develop the students’ knowledge and understanding within specific content areas. It has been a more recent development that strong reading skills and literacy development is necessary and demanded in all subjects. “Since the early days of research on reading, a strong relation between reading ability and vocabulary knowledge has been acknowledged.” (Cain, Oakhill, & Lemmon, 2004, p. 671). When students have entered high school with an obviously diminished lexicon, it is a difficult road for a content teacher to tread to facilitate a growth of the students’ non-content lexicon while still being held accountable for, and in turn, holding the students accountable for meeting the content standards. However, it seems to be an impossibility to accomplish one without the other. The students are expected to have basic literacy skills that many times are not present, but are crucial to the success of the student within the content area. Especially when working with populations from low socioeconomic groups that inherently have smaller and less developed lexicons mainly due to environmental factors, these groups read at lower reading levels and are less prepared to be successful within specific content areas.

There has been much research that has addressed the correlation between low socioeconomic status and literacy struggles. This discrepancy has been attributed to a multitude of sources of disadvantage among the students within this community. According to Spencer and Guillaume (2006), “Children who have poor vocabulary may
not understand much of the oral and written language they are exposed to. Children from low socioeconomic groups appear to be especially at risk and may not be able to catch up unless direct intervention in learning words is provided.” (p. 206). Today with all students being asked to perform to a certain set standard on high-stakes tests throughout all subject areas, it seems as though specific groups of students are being put at a disadvantage as a result of non-school related issues. Issues such as having less academically relevant life experiences that ultimately leads to a much less developed prior knowledge set from which to relate learning experiences. Also, these high-risk students having much diminished lexicons beginning at the primary grades, that then can snowball through the secondary levels and put these students farther and farther behind when compared to their cohort. Many of the state content assessments that are required for high school graduation are written at a comprehension level well above the grade level of the targeted students. After performing several informal reading level assessments on state content assessments, there have been instances where the assessments are shown to be written three to four grade levels above the targeted students. Due to the aforementioned issues, this problem seems to be exacerbated in schools that service at-risk populations from low socioeconomic groups.

Content area teachers have been explicitly teaching content area vocabulary as a necessity of their curriculum. Content area vocabulary has definitely been viewed as an essential tool to the understanding of the concepts within that discipline. It has not historically been the practice of content area teachers to focus on general literacy and building non-content vocabulary skills in hopes of better preparing their students for success within the content area. In more recent times, the push has been towards a
general, overarching approach to literacy where non-content vocabulary development and general literacy development will have to be an integral part of any curriculum. In response to the findings of the report of the National Reading Panel and those by No Child Left Behind (2002), Pearson, Hiebert, and Kamil (2007) said, “We think there is good reason to teach vocabulary more aggressively and even better reason to study its relation to comprehension more carefully,” (p. 282). Logically, it seems that if one has a developed working knowledge of more words in their lexicon, they would be able to better comprehend any text that they read. While this relationship is most likely much more complex and multidimensional, there needs to be somewhat of a starting point. Individual words are the building blocks of language and without knowledge and understanding of the building blocks; little meaning can be derived from the whole. Especially in specific content areas, such as science, there is specific non-content related vocabulary that impedes the success of the students.

This study will explore the effect of explicit teaching of commonly used non-content vocabulary that impedes the success of students in a secondary science classroom. In general, students have not seemed to struggle with content related vocabulary on state assessments due to the awareness and preparedness of the teachers to the need to develop the content vocabulary in order to connect conceptual knowledge. There has seemed to be an increasing struggle among students in deciphering the meaning of reading passages and assessment questions due to a lack of knowledge of more sophisticated vocabulary words. In this study, students in a secondary science classroom will be presented with state assessments and will be able to identify crucial non-content vocabulary words that would impede their success on the assessments.
These identified words will be explicitly taught and the assessment results of those students will be compared with the assessment results of students of a similar cohort that were not pre-taught the non-content vocabulary.
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Literature Review

This review of the literature addresses the many aspects of highly skilled readers and also those readers that struggle. The main focus is on an extensive, working vocabulary as a precursor to reading comprehension. Also addressed are factors, such as socioeconomic status, that limit the breadth and depth of individual students' personal dictionaries or lexicons. Also, in looking at the lexicons of successful and struggling students, strategies for categorizing those lexicons to better pinpoint the most effective strategies for teaching and supporting vocabulary development will be addressed. The common theme will be to address effective, strategic vocabulary development in order to foster an increase in reading comprehension.

The Qualities and Characteristics of Skilled Readers

When a new assignment, project, or learning experience has been introduced by a teacher to their students, an exemplary model should be provided at the outset so that the end goal is clear. With well planned lessons, the idea of keeping the end in mind when setting out to plan the lesson is essential. Similarly, when a well-planned approach to literacy education has been developed, the planners should have had an exemplary model of reading from which to work from so that they knew where they wanted their readers to end up. According to Alexander (2005), “Until we adopt a lifelong perspective (to reading), we continue to run the risk of turning out undeveloped, unmotivated, and uncritical readers unable to fulfill their responsibilities within a democratic society.” (p. 413). Having kept the end in mind Alexander (2005) said,

Several characteristics of lifespan reading development are: 1. Readers’ knowledge of language and knowledge of content domains are critical
forces in developing competence; 2. Readers' personal interest in reading becomes a driving force in their development as competence is achieved;

3. Lifespan development involves systematic changes in readers' strategic processing; 4. Reading development is a lifelong journey that unfolds in multiple stages; 5. Profiles of successful and struggling readers are reflective of developmental forces; 6. Readers in acclimation are especially vulnerable and in need of appropriate scaffolding. (p. 414)

To approach reading as a developmental process with specific benchmarks of processes that readers at each developmental level can accomplish, then to have characteristics of an exemplary reader gives educators a starting point to address struggling readers. Alexander (2005) stated, "Educators, the general public, and policy makers must do what they can to ensure a literate society—a society of competent readers, writers, speakers, and listeners." (p. 414). It used to be the reading teacher's job or the English teacher's job to ensure a literate society. This task has now been given to all. Parents, teachers (all teachers, not just reading and English teachers), mentors, politicians, and all other involved literate persons. It has become the job of all to ensure a competent, literate society for tomorrow.

Working within Alexander's first quality of lifelong readers where readers' knowledge of language and content are essential for success gets to the crux of the issue, synthesizing text into understanding. It is not enough to simply decode. the end goal is making meaning and comprehension of the text. (Alexander, 2005; Alexander, Schallert, & Hare, 1991). The idea of decoding as a measure of reading competence for students that are expected to be of the developmental level beyond the early primary grades does
not reflect an accurate measure. One of the end goals is comprehension. One needs knowledge of not only the language (decoding), but also have knowledge of the content (vocabulary/word knowledge). Alexander (2005) said, “As individuals build their knowledge of language, they are also building their knowledge of the ideas those letters and sounds signify. For instance, reading ‘c-a-t’ with meaning involves some understanding of what ‘cat’ represents.” (p. 418). As readers become more competent and begin to move into the next developmental level, the amount of knowledge that they have and the depth of knowledge should increase.

The next quality of a lifelong reader addressed interest as a driving force. Recently in education, the idea of interest has seemed to become skewed. Alexander described multiple types of interest that enlightened the issue. According to Alexander (2005), “Two distinct and, at times, competing forms of interest have been supported by the expertise research—individual interest and situational interest.” (p. 419). Alexander then went on to describe individual interest as what we think of as interest. A topic that is special or meaningful to an individual and also something that the individual has devoted a great deal of time to. The other form of interest, situational interest, seems to be of the utmost importance to content teachers. Situational interest in the classroom has been created by the teacher. Situational interest is the hook that teachers have strived to create in specific situations when new concepts or topics have been introduced. It is the attention-getter that turned all of the students’ heads. In other words, situational interest is the momentary arousal or temporary attention that teachers were then at the task of harnessing and developing. (Alexander, 2005; Mitchell, 1993). So, in a sense, any topic can spark interest if it is introduced correctly. The situational interest becomes quite
important to a developing reader so that they can experience a plethora of topics. This gives them the opportunity to realize their true individual interests which become of the utmost importance for the development of a lifelong reader.

The final important step to fostering the development of a lifelong reader is the systematic changes in readers' strategic processing. Competence required the skills of identifying, problem-solving, and resolving any problems that were confronted. There are strategies that, when developed, provide individuals with the tools to be successful. Predicting, questioning, summarizing, monitoring, and monitoring of learning and performance were some examples of strategies that successful readers have used, (Alexander, 2005). Using the developmental approach, these strategies should move the reader from more concrete strategies for navigating the text in the early stages of reading development to reflective metacognitive processes. According to Paris and Jacobs (1984), “Children who displayed the greatest awareness of reading strategies scored significantly better than low awareness children on both pretests and posttests,” (p. 2091). While strategies were necessary for success at all developmental levels, the same strategies were not appropriate for all reading developmental levels. The literature suggested that the goal of moving from very concrete, text navigating strategies to more of a metacognitive, interrelated, interconnected, deep processing approach should be adhered to. Alexander (2005) spoke to highly competent readers, “As important as their knowledge base and their strategic repertoire, highly competent readers display interest in the domain of reading or topics about which they are reading.” (p. 427). Working towards being a highly competent reader was the ultimate goal addressed in the literature. Also, the idea of being highly competent spoke to what the reader could do with the text
in terms of comprehension, synthesis between texts, and deep understanding on the metacognitive level.

**Relationship between Vocabulary and Reading Comprehension**

The basis for teaching reading since the dawn of education has been the development of a base knowledge of vocabulary. In simple terms, the more words that one knows, the higher the probability that they have encountered those known words in their reading experiences, the higher the probability for comprehension. (Cain, et al., 2004; Carroll, 1993). According to Laffey and Laffey (1986), “As any good reading teacher has known for years, building the students’ background knowledge to the words currently being studied will insure that a student will learn and use the new words. The words will become part of the students’ permanent language repertoire,” (p. 650). This implies that there cannot be fluency within the whole structure of language without a deep, working knowledge and understanding of its cogs. Those cogs are the words that make up the language. Within the working structure of a machine, if there is a missing, broken, or misplaced cog, the machine tends to malfunction. The questions that now present themselves are: what are these cogs? What is vocabulary?

If there is going to be a discussion on how important it is to develop and increase the amount of vocabulary individuals have one must first define vocabulary. According to Pearson, Hiebert, and Kamil (2007).

Any analysis of the domain of vocabulary assessment should first consider what it means to know a word. The first definition of *vocabulary* in the *Random House Webster’s Unabridged Dictionary* (Flexner, 2003) is “the stock of words used by or known to a particular people or group of
persons.' A subsequent definition is 'the words of a language.' In turn, word is defined as 'a unit of language, consisting of one or more spoken sounds or their written representation that functions as a principal carrier of meaning.' (p. 283)

If the working definitions of the terms "vocabulary" and "word" were synthesized, the result would be that knowing vocabulary is knowing meaning. This would lead to the conclusion that the more vocabulary that one had in one's lexicon, the higher level of comprehension one would have. If one was to derive meaning or understanding or a working knowledge from a text, ultimately, one would have been able to comprehend that text or that language. Ouellette (2006) stated, "Skilled readers must also recognize words rapidly and accurately, and the end goal of reading is intact comprehension." (p. 554). Having alluded to the fact that there is much more of a complex, processing relationship between vocabulary and comprehension, there is still the fact that one needs to walk before they can run. Students need to have had the words introduced, had opportunity to work with the words in order to build the ability to rapidly recognize due to familiarity, and ultimately have the words securely within their lexicon in order to work toward this end goal of intact comprehension. The larger and the richer that an individual's lexicon has become directly corresponds and greatly effects how quickly that individual was able to access their knowledge of a specific word. This process was determined to have a great effect on reading comprehension. (Cain, et al., 2004; Stahl and Fairbanks, 1986).
The literature has made the connection again and again between vocabulary and reading comprehension. In essence, the literature has said, the larger the lexicon, the greater ability for reading comprehension. According to Cain, et al. (2004), “A more useful framework for studying the relation between vocabulary knowledge and reading comprehension is provided by theories proposing a common skill or mechanism that contributes to the determination of both.” (p. 671). If there is a connection that has been determined, or a common skill or mechanism that contributes to both vocabulary acquisition and reading comprehension, the next step must be to isolate that mechanism or skill. Yovanoff, Duesbery, Alonzo, and Tindal (2005) said, “Vocabulary knowledge is a significant and constant predictor of overall reading comprehension irrespective of grade level.” (p. 4). Throughout the literature, there seemed to be two interrelated perspectives in regards to the actual relationship between vocabulary or word knowledge and reading comprehension. One of these perspectives was more of a processing perspective that did not downplay the importance of vocabulary, but alluded to the possibility that the cognitive processes that are in place to learn and develop a working knowledge of vocabulary are similar to those processes of comprehension. The other perspective placed more of an emphasis on a more direct relationship between actual sizes of individuals’ lexicons to their reading comprehension ability.

On the view of the interrelatedness of the cognitive processes at work between vocabulary acquisition and knowledge and reading comprehension, Nagy and Scott (2000) commented. “To many, the word vocabulary may suggest a reductionist perspective in which words are learned by memorizing short definitions and sentences are understood in a strictly bottom-up fashion by putting together the meanings of individual
words—a picture inconsistent with our current understanding of the reading process.” (p. 269). From here, the idea of the traditional view of teaching reading through direct instruction of vocabulary transformed into a more whole language approach where students were not directly taught language, but exposed to a plethora of literature where it was thought that the cogs of the machine would naturally fall into place. If the end goal of comprehension is procedurally and cognitively identical to vocabulary knowledge, acquisition, and the reading process as a whole then logically, it would be counterproductive to teach vocabulary directly. Nagy and Scott (2000) went on to say, “Any attempt to understand the processes by which children’s vocabularies grow must be based on a recognition of the complexity of word knowledge.” (p. 270). Traditional, reductionist vocabulary instruction may not have been the most efficient or appropriate direction for comprehension development, but ignoring the correlation between lexicon development and comprehension is also wholly inappropriate. A better approach seems to have been to address the complexity and multidimensionality of vocabulary and word knowledge. According to Nagy and Scott (2000), “Here we want to emphasize the point that word knowledge is primarily procedural rather than declarative, a matter of ‘knowing how’ rather than ‘knowing that.’” (p. 273).

Vocabulary acquisition has been simply memorizing definitions and not learning to use the words or work with the words and the word meanings. Now, the literature has differentiated the idea that vocabulary acquisition is much more of a multidimensional, metacognitive process. Working within this new paradigm of word knowledge instead of vocabulary memorization leads to the correlation of reading comprehension. Mezynski (1983) stated, “Students’ knowledge of word meanings is an important factor in their
performance on reading comprehension tasks. Factor analyses of reading comprehension tests consistently found a substantial proportion of variance accounted for by vocabulary knowledge.” (p. 253). One skill that has been taught for vocabulary acquisition has been the use of the context of the text to determine a reasonable meaning for the unknown word. This higher level, sophisticated, synthesis process has been difficult for many struggling readers. Those readers that already had a higher level vocabulary, word knowledge have had much more success due to the ability to synthesize more aspects of the text. (Cain, et al., 2004; McKeown, 1985). Basically, the traditional, word-definition vocabulary training has been shown not to be sufficient. There needs to be more of a complex, in depth study of words. According to Ouellette (2006), “Children may store a word form in their lexicon, contributing to their vocabulary breadth, without fully understanding that word’s meaning. Over time, word meanings are refined, adding to the child’s depth of vocabulary knowledge.” (p. 555). Again, this referred back to the cognitive processing aspect that seems to be integral at achieving comprehension.

Without a deep, working knowledge and understanding of the words that make up the text, which leads to connections between words and forms of words and multiple meanings of words, meaning and comprehension, cannot be achieved. Ouellette (2006) went on to say, “Depth of vocabulary knowledge contributed to visual word recognition through its association with expressive vocabulary and directly predicted reading comprehension beyond the measures of vocabulary breadth.” (p. 562).

**Socioeconomic Status as a Predictor of Reading Comprehension**

The literature has shown a multitude of data to support the correlation between low socioeconomic status and smaller, less developed lexicons, slower vocabulary
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acquisition, less developed word knowledge, and ultimately significantly lower levels of reading comprehension. Many of the reasons and precursors to the literacy status of low socioeconomic status students have been documented as environmental such as having had less exposure to books at home, parents that have been less involved, and a lower likelihood that those students have been read to when they were young. (Aikens & Barbarin, 2008; Evans, 2004; Federal Interagency Forum on Child and Family Statistics, 2005; Lee & Burkam, 2002; Vernon-Feagans, Hammer, Miccio, & Manlove, 2002; Whitehurst & Lonigan, 1998). All of these factors seem to contribute to a sector of the population that is less prepared to start school and is perpetually put at a disadvantage in all subject areas, including literacy, vocabulary, and reading comprehension. McCoach, O'Connell, Reis, and Levitt (2006) said, “The most important finding from this study relates to the impact of poverty on learning. Socioeconomic status appears to be a strong predictor of students’ reading achievement at kindergarten entry. Unfortunately, students with lower initial reading skills tend to lag behind their peers in reading achievement.” (p. 26).

Much of the focus of the literature tended to be primarily around the time when students entered school. Preparedness of students entering school seemed to be a viable indicator for reading comprehension abilities as well as all other academic areas for the duration of the students’ academic career. The literature has shown that there were discrepancies in reading skills and comprehension when low socioeconomic status students were compared with their peers from middle and upper socioeconomic statuses. This gap was prevalent by mid to late elementary school. (Chall, Jacobs, & Baldwin, 1990). Logically, these findings lead the researcher to look for factors that lie beyond the
classroom. It seems as if these students are entering school dismally underprepared when compared to their upper to middle level socioeconomic status peers. Academically, including vocabulary and reading comprehension, the low socioeconomic status students are held up in the starting gates. According to Sirin (2005), "Overall findings, therefore, suggests that parents' location in the socioeconomic structure has a strong impact on students' academic achievement," (p. 438). The question that then begs to be answered is why?

Family socioeconomic status seems to have predeterminded success for many students entering school from the ranks of a low socioeconomic status. Part of the equation was resources that could be bought with money within the family structure such as books, newspapers, and periodicals. Statistics have shown that families of low socioeconomic status tended not to have such literary materials readily available around the house. Other factors that have been shown to contribute to students from low socioeconomic status lagging behind include parents that were not successful in school themselves, parents that do not hold jobs that require high levels of literacy, and other cultural factors that do not stress academic success as a priority. (Coleman, 1988; Holt & Smith, 2005; Sirin 2005; Stedman, Tinsley, & Kaestle, 1991). If the incoming students have not been provided with learning opportunities or have not been exposed to the plethora of new, higher order vocabulary, or have not been exposed to an environment where education and academic success is promoted, they have yet again been put at a disadvantage when compared to their peers in other socioeconomic levels. Sirin (2005) concluded, "The overall finding, therefore, not only reflects the effect of resources at home but also may reflect the effect of social capital on academic achievement." (p. 438).
There have been other documented socioeconomic differences and disparities that also reflect cultural differences among these populations. Simple cultural differences that have been observed that have been attributed to this cultural and socioeconomic disparity in literacy development and reading comprehension were things such as the style of communication between parent and child. If and when parents used ways to objectify language, such as the use of slang, there have been associations with differences in students' literacy acquisition and achievement. (Heath, 1983; Holt & Smith, 2005). Early in the cognitive development of children, exposure and modeling of proper language techniques and exposure and repetition of new, higher-level vocabulary is of the utmost importance for future success academically in school, as well as having significant repercussions in later abilities to acquire new vocabulary and incorporate that new vocabulary into their working lexicon. According to Aikens and Barbarin (2008), "Accordingly, family life can be viewed as being strongly associated with the starting point of children's reading competence, with other ecological settings being more strongly associated with the children's reading progress." (p. 248).

Finally, while the research concludes that students entering school from a low socioeconomic status are disadvantaged academically, especially in the areas of literacy, vocabulary acquisition, and reading comprehension, when compared to their peers from more of a middle or upper socioeconomic status due to a multitude of home and family environmental reasons; there are other factors at work that disadvantage this aforementioned group once they enter school. The data seems to have shown that there is not a gap in achievement once the students entered school. The students from low socioeconomic status entered school already behind their higher socioeconomic status.
peers and also tended to fall even further behind during other non-instructional periods. (Entwisle, Alexander, & Olsen. 2005; McCoach, et al., 2006). Whether it is the culture, the need to work to help support the family, or other social, cultural, and economic factors, the problem has been shown to lie primarily in the non-instructional region. Aikens and Barbarin (2008) discussed other aspects of the community in which the low socioeconomic status student resides. “Community support for the school and poor physical conditions surrounding the school were associated with children’s reading. Our analyses also suggest a compounding effect of low quality environments. Children from low socioeconomic homes grow up in environments poor in literacy experiences.” (p. 249). Other cultural and environmental pressures that students from low socioeconomic status backgrounds may experience during non-instructional periods may be peer pressure that drives them away from academically relevant experiences. They may experience pressure to stay loyal to their socioeconomic group. The literature has shown that even extremely capable low socioeconomic status students have purposefully performed below their capabilities by disguising their academic abilities in order to continue avoid being singled out and to be able to continue to align themselves within their cultural comfort zone. (Fordham, 1996; Holt & Smith, 2005). When it comes to shirking pressures from peers and moving outside of cultural comfort zones, the task can be large. Unfortunately, many capable students have been lost to this type of behavior and have in turn perpetuated the cycle of poverty and lack of education in their family.

Categorizing Vocabulary Words for Study

Thus far, the importance of word knowledge has been discussed to the lengths of if just a broad, shallow, reductionist approach to vocabulary is taken, there will be little
benefit in terms of an increase in comprehension. However, if an approach that addresses process, creating a deep, working understanding of words, the interconnectedness, multidimensionality, multiple meanings, and overall depth of vocabulary is taken, there seemed to be a direct correlation between vocabulary development and comprehension. According to Beck, McKeown, and Kucan (2002), “Indeed, a large vocabulary repertoire facilitates becoming an educated person to the extent that vocabulary knowledge is strongly related to reading proficiency in particular and school achievement in general,” (p. 1).

The literature developed a classification system for vocabulary. This classification system helped to focus the word study for students struggling with vocabulary acquisition and reading comprehension. This classification system has devised a system to organize vocabulary words into three main categories, or tiers. These tiers were created on the baseline of an educated, mature, literate individual’s lexicon. (Beck & McKeown, 1985). The first tier tends to consist of basic, simple, high frequency words that are extremely familiar to all individuals. Examples of these first tier words that were provided by Beck, et al. (2002) are, “The first tier consists of the most basic words—clock, baby, happy, walk, and so on. These words require virtually no instructional attention.” (p. 8). Words that occupy the third tier tend to be content words. These words have very specific, single meanings that relate directly to a specific content area. Beck, et al. (2002) said, “The third tier is made up of words whose frequency of use is quite low and often limited to specific domains. Some examples might be isotope, lathe, peninsula, and refinery.” (p. 8). These are words that secondary level content teachers expect that their students do not know. Specific, planned, and significant
amounts of instructional time are dedicated to these words and content teachers have been prepared with strategies within their discipline to help their students incorporate these Tier Three words into their lexicons. Beck, et al. (2002) stated, “The second tier contains words that are of high frequency for mature language users and are found across a variety of domains. Examples include coincidence, absurd, industrious, and fortunate.” (p. 8). Tier two words have been and will continue to be the obstacle for most learners, especially those from lower socioeconomic backgrounds. Pearson, et al. (2007) commented, “As such, they (tier two words) constitute the language of sophisticated academic discourse.” (p. 291). If these words or this language has not been required in the homes of students from low socioeconomic status, then the exposure and the repetition needed in order for these students to have acquired this vocabulary knowledge was not there.

Within specific content areas, when addressing comprehension issues, it is rarely the Tier Three words that cause the problem. It tends to be the Tier Two words that tend to be essential to the comprehension of the overall section of text. Especially with at-risk students from lower socioeconomic backgrounds that have inherently smaller lexicons, they have been put at a severe disadvantage when compared to their peers of middle to upper socioeconomic backgrounds. Having inherently smaller lexicons, those at-risk students then have less opportunity for vocabulary development statistically, which then decreases their comprehension of Tier Two vocabulary, which then ultimately leads to less success.

One strategy that would be possible to identify the Tier Two words so that they could be addressed and taught was suggested by Beck, et al. (2002), “One ‘test’ of
whether a word meets the Tier Two criterion of being a useful addition to students' repertoires is to think about whether the students already have other words in their lexicon that they use in place of the Tier Two word. (p. 16). Putting this idea into the context of a secondary content area teacher that has been experiencing difficulties with students' comprehension due at least somewhat to deficient lexicons, the teacher could use the students as the guide. Instruction is driven by students: let the students identify the Tier Two words that have been the struggle. Once the Tier Two words that the students struggle with are identified, those words need to become a constant aspect of the classroom vernacular.

Ultimately, it seems as though developing a larger, more highly developed, workable Tier Two lexicon can build a bridge to success for students in specific content areas. This more highly developed repertoire of Tier Two vocabulary will allow students to understand what a specific question is asking and not have comprehension impeded or hindered by unknown vocabulary. This will also allow students to then, in turn, demonstrate their workable knowledge of the essential Tier Three vocabulary which is necessary to achieve success in their specific content area. Finally, if these Tier Two words are hindering the students' ability to comprehend text or derive meaning from questions, they are ultimately unable to demonstrate their knowledge and understanding of the content because they may not know or understand what they are being asked to do or what knowledge or understanding they are being asked to demonstrate.

**Effective Strategies for Teaching Vocabulary**

There have been multiple effective strategies for teaching vocabulary; however there seems to be a few common themes among the various approaches. The
commonality among these proposed strategies seem to have been the result of general, overarching research findings. According to Graves (2007):

Among the research findings testifying to its importance are: 1. Vocabulary knowledge in kindergarten and first grade is a significant predictor for reading comprehension in the middle and secondary grades; 2. Vocabulary difficulty strongly influences the readability of text; 3. Teaching vocabulary can improve reading comprehension; 4. Growing up in poverty can seriously restrict the vocabulary children learn before beginning school and make attaining an adequate vocabulary a very challenging task; 5. Lack of a vocabulary can be a crucial factor underlying the failure of many students. (p. 13)

A common agreement among the research has been that repetition is a crucial factor of the incorporation of the new vocabulary word into the students’ lexicon. According to Spencer and Guillaume (2006), The richer and more varied students’ experiences related to particular concepts, the more finely detailed and nuanced their understanding of related terms can be expected to be.” (p. 208). Past practice on vocabulary development has been to define the word, sometimes using a dictionary definition that the student also did not understand, and then to use that word in a sentence. The literature discussed developing a deeper understanding to word knowledge that is needed in order to impact comprehension. Nichols and Rupley (2004) said, “Vocabulary instruction that never allows students the opportunity to fully own new words, such as copying a list of words’ definitions from a dictionary and flashcard activities provides no active or actual learning of the new concept associated with the word.” (p. 58). The repetition needs to happen in
multiple contexts, at different times, express the multidimensionality of the word, and the students’ themselves need to be required to use the word in their daily activities in class. The literature discussed the need for a multifaceted approach to vocabulary development with multiple encounters with the words and the opportunity to use them. The students needed to be immersed in the language through all facets of literacy, reading, writing, listening, and speaking. (Beck, et al., 2002; Graves, 2007).

Another common agreement among the research has been that the students need to be able to connect these new vocabulary words to their experiences. In other words, there has to be some sort of prior knowledge that the words are built off of. Studies have shown that the traditional method of having students look up the definition in the dictionary does not equal increased comprehension. This goes back to the aforementioned breadth versus depth argument. Several studies discussed in the literature addressed a traditional approach to vocabulary development such as words looked up in the dictionary may increase breadth of vocabulary knowledge, but no corresponding increase in reading comprehension was followed by this approach. (Dole, Sloan, & Trathen, 1995; Stahl & Fairbanks, 1986). It seems that it is a depth of vocabulary and word knowledge that is needed for an increase in reading comprehension. Without a context with which to place the new vocabulary word, without the ability to experience the new vocabulary word in multiple contexts, and without the ability to connect the vocabulary word within the text and to their prior knowledge, the students will have a much diminished ability to fully incorporate that new vocabulary word into their lexicon. Spencer and Guillaume (2006) said, “When students are engaged in firsthand experiences they spontaneously activate their prior knowledge, which helps to
prepare them for new learning,” (p. 208). If the students have experienced the concept and have a prior knowledge, the acquisition of the vocabulary word has a higher potential. True understanding of words and language come from higher-level thought, metacognition, and the development of the knowledge of word relationships. (Beck, et al., 2002). Understanding the relationships, multiple meanings, and a deep word knowledge has been correlated to increased reading comprehension.

There currently seems to be an emphasis being put on the importance of decoding as a bridge to comprehension. The theory behind this method is that if the reader can decode the text by sounding out the words, they will then be able to recognize the words within the text, then process through to the next step of synthesizing the information into comprehension of the text. While this strategy, in theory, should make sense, the problem arises that the reader that is decoding has an extremely small lexicon from which to draw from and ultimately makes no sense or meaning from the text. Students that only have skills to decode have not shown an ability to successfully comprehend what they decode. The processing piece has been shown to have been lacking because of a lack of word knowledge and simply a lack of recognition. The words that the students have decoded have no meaning to those students. Therefore, with no meaning of the words, there was no comprehension. (Heilman, Blair, & Rupley, 2002; Nichols & Rupley, 2004). Ultimately, decoding is an initial step to literacy and is definitely an essential piece to fluency. However, without workable word knowledge, decoding is useless. Yovanoff, et al. (2005) define the reading as a combination of fluency and vocabulary knowledge. The decoding piece is contained within the fluency aspect of reading. However, Yovanoff, et al. (2005) went on to say, “Once a certain minimal fluency level has been
reached—indicating that a student is no longer focusing on decoding individual phonemes but has, instead, reached a sufficient degree of automaticity in reading—then vocabulary knowledge becomes a more informative indicator of reading comprehension.” (p. 5). This is an extremely important point which demonstrates that it is not until decoding text becomes an automatic process, can one start to incorporate new vocabulary, connect new vocabulary, or learn new vocabulary in context. This also explains that until the process of decoding becomes automatic, vocabulary knowledge would be segmented. Early in their education, students have been put to the task of learning to read. This does involve learning to decode, but simultaneously building their working lexicon. Once students have left elementary school, they have been asked to read to learn. They have been put to the task of synthesizing and using all of the knowledge base that they have developed in elementary school. (Rayner, Foorman, Perfetti, Pesetsky, & Seidenberg, 2001; Yovanoff, et al., 2005). Reading is a complex, multidimensional, interrelated, interconnected process. The beginning in the earlier grades of the learn to read piece is where decoding skills come into play. That skill should then become automatic and vocabulary development along with incorporation of new vocabulary into the lexicon should take over. The more highly developed reader has developed strategies for incorporating new vocabulary into their lexicon through context learning. Learning and incorporating new vocabulary through context learning is a very high level process. Eventually, this process should become more of a metacognitive process, more of a reflective process in regards to incorporating new vocabulary into the lexicon.
Spencer and Guillaume (2006) stated, "In science and in reading education, as in education in general, a major goal is for students to become lifelong learners. In order for this to occur, students must develop the motivation and skills necessary to take charge of their own learning." (p. 209). Metacognition, or thinking about one's thinking processes is the ultimate goal in education, because then, one becomes a self-sufficient learner. If students have had training in the development of their metacognitive skills, the literature has shown that the development of the mechanism or process that encompasses vocabulary acquisition and reading comprehension would be strengthened, (Blachowicz, 1986; Lubliner & Smetana, 2008). The self reflection of metacognition allows the learner to be reflective about what they are thinking, how they are thinking, and why they are thinking what they are thinking. Ultimately, the process of metacognition should allow the learner to process how can they connect what they are thinking or reading or being exposed to back to what they know and to what they have experienced. Spencer & Guillaume (2006) said.

In order to be successful, independent learners, students need to develop the skills to monitor their word knowledge by being aware of the varying depth of knowledge they have of terms, know how to find and use resources to enrich and clarify their knowledge when needed, and reflect on changes in understanding as their word knowledge grows. (p. 209)

In order to achieve a truly reflective, intrinsically motivated, metacognitive, and life-long learner there has to be a sense of investment and authentic engagement on the part of the learner. Learning was meant to be an active and reflective process, not a punitive process. In order to for students to work toward the achievement of the aforementioned
goal of developing the skills of a life-long learner. Instruction on how to begin to utilize these upper-level cognitive processes is needed. Teachers have the ability to foster development of metacognitive skills by the simple use of them in class and by some instructional techniques such as the think-aloud. (Baumann, Jones, & Seifert-Kessel, 1993; Spencer & Guillaume, 2006). There are also many other strategies that encourage and promote learning and incorporating new vocabulary as an active, reflective, metacognitive learning process. Nichols and Rupley (2004) commented. “Vocabulary strategies such as concept wheels, semantic word maps, webbing, semantic feature analyses, and teaching relationships among words are effective tools that incorporate many of the guidelines for the active processing of vocabulary.” (p. 58). According to the literature, the key seemed to be to focus on active strategies where the students were actively engaged and working with the words. This provided opportunities for deep lexical development which has been shown to foster and increase in reading comprehension.

Summary

In this literature review, there have been five main sections that addressed the overarching theme of non-content vocabulary development that would foster reading comprehension in content areas, specifically a secondary science classroom. The first section addressed background as to what qualities and characteristics that good readers possessed was addressed. Within this section, the theme of a large, workable, well developed lexicon was established. From there, research as to the connection between vocabulary and reading comprehension was reviewed. There was a large body of literature to support the correlation between a well developed vocabulary and reading
comprehension. However, within the literature, there was a large push towards not just developing a large breadth of vocabulary knowledge, but also and more importantly a depth of vocabulary knowledge. The ability to recognize multiple forms, multiple meanings, and multiple contexts, and the ability to relate these words to a conceptual background were of the utmost importance in terms of comprehension.

The literature then delved into discussions on discrepancies between socioeconomic groups in vocabulary acquisition, word knowledge, and reading comprehension. The literature focused on environmental and cultural factors that contributed to the discrepancies between low socioeconomic status students and middle to upper socioeconomic status students. Interestingly, although the low socioeconomic students enter school behind in terms of their lexical preparedness, while school was in session, there was very little discrepancy among the groups. The literature showed high levels of discrepancies occurring in non-instructional periods, not during instructional periods.

In the last sections the literature laid out current categorization strategies of vocabulary hierarchies and current teaching strategies. The focus of the current categorization was on Tier Two words, or sophisticated words that are used in high frequency by educated persons. These seem to have been the target words for struggling readers. The strategies for teaching vocabulary focused mainly on active engagement strategies where the students were required to participate in their learning and work towards the development of metacognitive strategies.
Methodology

It has been observed that students within a secondary science, New York State Regents Living Environment classroom have had tendencies to struggle to gain comprehension of state assessment questions. There has been a multitude of conjecture among colleagues as to the nature of this issue, but as there has been more questioning and informal, formative assessment of the students, a hypothesis of non-content vocabulary struggles working as a hindrance to comprehension, has been formulated. Other factors contributing to this limited lexicon of the students have been attributed to the low socioeconomic status of many of the student body. There has been much research documented in the literature to support a strong correlation between low socioeconomic status and severely diminished lexicons. This study has therefore attempted to address the struggles of comprehension that students have had in comprehension of New York State Regents Living Environment questions by targeting and directly teaching non-content vocabulary that has seemed to hinder the success of students in a school that services a population of high need students from low socioeconomic backgrounds.

Participants

There were three groups that were identified and participated in this study. These three classes were all enrolled in the New York State Regents Living Environment course. Class A was comprised of 22 total students, nine males and 13 females. Class A was made up of 18 ninth grade students, three tenth grade students, and one eleventh grade student. This was the first time that all 22 students had taken the course. Within Class A, there was one identified special education students that received services. Class
B was comprised of 21 total students, 12 males and 9 females. Class B was made up of 19 ninth grade students and two tenth grade students. This was the first time that all students had taken the course. Within Class B, there was one identified special education student that received services. Class C was comprised of 25 total students, 11 males and 14 females. Class C was made up of 16 ninth grade students, six tenth grade students, and three eleventh grade students. This was the first time that all students had taken the course. Within Class C, there were four identified special education students that received services and 10 ESOL students that received services. An ESOL teacher pushed into Class C every class period.

**Instruments and Materials**

The instruments that were used in this study were developed to give the students a vehicle to identify any and all vocabulary words that they were not familiar with and would have ultimately impeded their success of comprehension of these assessment questions. The first instrument which is documented as Appendix A provided the students the opportunity to identify all words within a particular assessment with which they were unfamiliar. This document allowed for all unknown words, content related and non-content related, to be identified. Having had the students derive the list of unknown words allowed for the students to take ownership of their learning, provided a baseline lexicon that the state assessment used, and provided the opportunity for the students to see commonalities among the vocabulary used within the state assessment.

The second instrument which is documented as Appendix B allowed the students to categorize their identified unknown words into content related vocabulary and non-content related vocabulary. This took place as more of a teacher directed activity because
answer on the New York State Regents final exam. As a note, Assessment A, Assessment B, and Assessment C were comprised of randomly selected questions from the standards addressed in each of the aforementioned units. These instruments were the basis of the quantitative section of this study.

In the first stage of the research, students in Class A, Class B, and Class C generated a list of unknown vocabulary using the assessments listed above. Along with the student generated list of unknown vocabulary, the teacher supplemented the list with additional non-content vocabulary words that were not on the student generated list that the teacher was frequently approached with in the classroom. This comprehensive list ultimately became the non-content vocabulary list represented in Appendix C.

In the second stage of the research, Class A was given Assessment B and Assessment C without the use of the unknown non-content vocabulary list. Class A was then provided with the unknown non-content vocabulary list and was given Assessment A. Assessments B and C served as the control and was the basis of comparison for the quantitative section of the study. Class B was given Assessment A and Assessment C without the use of the unknown non-content vocabulary list. Class B was then provided with the unknown non-content vocabulary list and was given Assessment B. Assessments A and C served as the control and was the basis of comparison for the quantitative section of the study. Class C was given Assessment A and Assessment B without the use of the unknown non-content vocabulary list. Class C was then provided with the unknown non-content vocabulary list and was given Assessment C. Assessments A and B served as the control and was the basis of comparison for the quantitative section of the study.
Procedures

As a preliminary stage to this research, the students engaged in a deep study of the commonly occurring non-content vocabulary that impedes reading comprehension of New York State Living Environment Regents questions. In the first stage, over the course of several classes, students were provided with assessments with questions that were a representation of the content from the Science Skills Unit, the Ecology Unit, the Evolution Unit, the Cells Unit, the Digestion Unit, the Circulation and Immunity Unit, and the Respiration and Excretion Unit. The assessments included their previous unit exams as well as their midterm exam. From these assessments, using the research instrument in Appendix A, the students generated a comprehensive list of non-content and content vocabulary with which they were did not have a deep, workable comprehension. The standard by which the students gauged their comprehension of the vocabulary was to ask themselves if they could explain the definition of the word, in simple terms, to an elementary student. After this initial list was generated, the students worked together and with the teacher to categorize their comprehensive content related and non-content related vocabulary list into an exclusively non-content vocabulary list using the research instrument represented in Appendix B. From those lists, the teacher compiled the vocabulary, with the addition of other non-content vocabulary words that the teacher felt appropriate to include due to the high frequency of students struggling with that specific vocabulary. This comprehensive vocabulary list became the research instrument in Appendix C. It was this list that was provided to the students to use on the designated experimental assessments as a quantitative comparison to see the effect of non-content vocabulary on reading comprehension in a secondary science classroom.
In the next stage of the research, the quantitative data collection stage, Class A was presented with Assessment B and asked to complete the activity without use of the non-content vocabulary list. Through questioning, Class A provided feedback pertaining to Assessment B that was documented in the qualitative section of the research. Class A was then presented with Assessment C and asked to complete the activity, again, without use of the non-content vocabulary list. Through questioning, Class A provided feedback pertaining to Assessment C that was documented in the qualitative section of the research. Class A was then presented with the non-content vocabulary list and was asked to re-familiarize themselves with the list. Class A was then presented with Assessment A and was asked to complete the activity along with the use of the non-content vocabulary list as a tool for any vocabulary words that they encountered with which they were unfamiliar. Through questioning, Class A provided feedback pertaining to Assessment A as well as the non-content vocabulary list and its helpfulness in increasing their comprehension of the questions contained within Assessment A when compared to Assessment B and Assessment C. This data was documented in the qualitative section of this research. Finally, the class averages of Assessment A, Assessment B, and Assessment C were compared to see any quantitative relationship between the assessments where the non-content vocabulary list was utilized by the students in Class A and where the non-content vocabulary list was not utilized.

Next, Class B was presented with Assessment A and asked to complete the activity without use of the non-content vocabulary list. Through questioning, Class B provided feedback pertaining to Assessment A that was documented in the qualitative section of the research. Class B was then presented with Assessment C and asked to
complete the activity again without use of the non-content vocabulary list. Through questioning, Class B provided feedback pertaining to Assessment C that was documented in the qualitative section of the research. Class A was then presented with the non-content vocabulary list and was asked to re-familiarize themselves with the list. Class A was then presented with Assessment B and was asked to complete the activity along with the use of the non-content vocabulary list as a tool for any vocabulary words that they encountered with which they were unfamiliar. Through questioning, Class B provided feedback pertaining to Assessment B as well as the non-content vocabulary list and its helpfulness in increasing their comprehension of the questions contained within Assessment B when compared to Assessment A and Assessment C. This data was documented in the qualitative section of this research. Finally, the class averages of Assessment A, Assessment B, and Assessment C were compared to see any quantitative relationship between the assessments where the non-content vocabulary list was utilized by the students in Class A and where the non-content vocabulary list was not utilized.

In the next stage of the research, the quantitative data collection stage, Class C was presented with Assessment A and asked to complete the activity without use of the non-content vocabulary list. Through questioning, Class C provided feedback pertaining to Assessment A that was documented in the qualitative section of the research. Class C was then presented with Assessment B and was asked to complete the activity, again, without use of the non-content vocabulary list. Through questioning, Class C provided feedback pertaining to Assessment B that was documented in the qualitative section of the research. Class C was then presented with the non-content vocabulary list and was asked to re-familiarize themselves with the list. Class C was then presented with Assessment C
and was asked to complete the activity along with the use of the non-content vocabulary list as a tool for any vocabulary words that they encountered with which they were unfamiliar. Through questioning, Class C provided feedback pertaining to Assessment C as well as the non-content vocabulary list and its helpfulness in increasing their comprehension of the questions contained within Assessment C when compared to Assessment B and Assessment C. This data was documented in the qualitative section of this research. Finally, the class averages of Assessment A, Assessment B, and Assessment C were compared to see any quantitative relationship between the assessments where the non-content vocabulary list was utilized by the students in Class C and where the non-content vocabulary list was not utilized.
Results

This study was conducted to ascertain the effect of non-content related vocabulary on reading comprehension on the New York State Living Environment Regents exam. The data was collected from three Regents Living Environment classes mainly comprised of ninth grade students and was the product of three separate assessments containing Regents questions selected from previously learned topics. These results are the product of this study.

Quantitative Results

The quantitative results of the study on the effect of non-content vocabulary on the reading comprehension of the students in a secondary science classroom were somewhat ambiguous. When comparing the average of Assessment A, Assessment B, and Assessment C of each individual student, noting which assessment the non-content vocabulary list was made available to them on, there was definitely mixed results. Some students did in fact score higher on the Assessment where the non-content vocabulary list was made available to them and some did not. As a note, when comparing the readability of the three assessments, Assessment A, Assessment B, and Assessment C using the Flesch-Kincaid Readability assessment, Assessment A was assessed at an 11.5 grade level, Assessment B was assessed at a 12 grade level, and Assessment C was assessed at a 12 grade level. Thus these assessments were fairly comparable in terms of readability.

As shown in table 1, Class A and Class C both showed an increase in average score on the assessments when the vocabulary sheet was used versus when it was not used. However, in both Class A and Class C, the average scores of the assessments using the non-content vocabulary list and not using the non-content vocabulary list was under a
5.0% difference. This small statistical margin made these results not significant thus there was essentially no significant difference between the non-content vocabulary list being used or not being used on the assessments used in this study. The results in Class B were a bit confusing. Statistically, there was a 7.1% decrease in the average score when the non-content vocabulary list was used when compared to the average score when the non-content vocabulary list was used.

As shown in figure 1, there was no significant difference when comparing the average score of Class A, B, and C using the non-content vocabulary list on their respective assessments and not using the non-content vocabulary list. Actually, the overall average difference between Class A, B, and C using the non-content vocabulary list and not using the non-content vocabulary list was 0.3%. Therefore, quantitatively, for the purposes of this study, there was no significant difference when comparing the average score of Class A, Class B, and Class C when they were using the non-content vocabulary list and when they were not using the non-content vocabulary list.

**Qualitative Results**

The overall summary of the qualitative data was extremely positive. Immediate reactions of the students to the access of the non-content vocabulary list produced comments that truly showed that the students were aided by the use of this tool. One student said, “This list really helped me understand the questions better, can we use this (list) on every test?” Another student commented, “Using the list really helped.” A third student asked, “Why haven’t we been using this all year? Are we going to be able to use it on our tests and quizzes from now on?”
The student reaction was quite overwhelming in favor of continuing the use of the non-content vocabulary list on future assessments. While the quantitative results did not show a significant increase in average score on the Assessments A, B, and C when comparing the assessments where the non-content vocabulary list was used and assessments where the non-content vocabulary list was not used, the student reaction and motivation for using the non-content vocabulary list on future assessments led to a classroom change of allowing the students to use the non-content vocabulary list on all future assessments.
Discussion

The quantitative results were discouraging on the surface, but when paired with the qualitative results from the study, there were some very encouraging aspects to this overall study. First, as stated in the methodology section, the participants in this study were primarily in ninth grade. The New York State Living Environment Regents course and exam, across New York State, was a course designed to be targeted to students in the ninth and tenth grades. As shown in the results section, the Flesch-Kincaid Readability Assessment of this cross-section of Regents questions that were supposed to be targeted to a ninth and tenth grade audience were written at a twelfth grade reading level. When it was taken into account that the readability of these questions resided approximately three to four grade levels above the targeted audience of these questions, assuming that all students are reading on grade level, it would make sense that just simply having a list of vocabulary words would not translate into students being able to read three to four grade levels above where they are supposed to be able to read. Ouellette (2006) stated, “Skilled readers must also recognize words rapidly and accurately, and the end goal of reading is intact comprehension,” (p. 554). Having reviewed individual student data, the students that performed consistently well on the assessments in this study, were the same students that performed consistently well on assessments throughout the course, were the students that read for comprehension at a high level. Decoding words, using vocabulary lists, and using context clues all represented excellent strategies for good readers that had the ability to not only read for understanding, but then could take that understanding of the reading and synthesize that knowledge and make connections to other knowledge to draw conclusions. However, if a section of text was not written at an appropriate
developmental level, all that would be extracted from that section of text would be discreet, decoded word meanings. Along with not having had an appropriate lexicon, synthesis, making connections to prior knowledge, and ultimately drawing conclusions from a reading passage that one did not comprehend would be an impossibility. The end goal of reading is comprehension. Comprehension is a multilayered, multifaceted, metacognitive process of the use and synthesis on one's lexicon to create understanding. Relating this back to the overtly inappropriate questions that these students were being asked to read, comprehend, connect to the content that they had learned throughout the course, and then arrive at a logical answer was reflected in their actual average scores on the assessments.

*Socioeconomic Status of the Student Population*

The students that participated in this study were an extremely diverse group that represented a wide variety of racial, ethnic, and socioeconomic backgrounds. The socioeconomic status of the student population within the school where this study took place was looking toward a future of a drastically increasing percentage of students that qualified for free and reduced lunch services. The percentage of students in the school that were qualified for free and reduced lunch services at the time of the study was in the range of 40%-50%. This number has been in great fluctuation due to the large transient population within the school. Along with such a large transient population, there were many other issues and factors that contributed to an inherently smaller and less developed lexicon. One of the major factors that contributed to this smaller and less developed lexicon and comprehension ability were many instances of interrupted and segmented educational experiences. As an indicator for where the school is currently headed in
terms of poverty, several of the feeder schools already surpassed 50% free and reduced lunch services for their student populations and were increasing towards 60% free and reduced lunch. There has been much research that has addressed the correlation between low socioeconomic status and literacy struggles. This discrepancy has been attributed to a multitude of sources of disadvantage among the students within this community.

According to Spencer and Guillaume (2006), "Children who have poor vocabulary may not understand much of the oral and written language they are exposed to. Children from low socioeconomic groups appear to be especially at risk and may not be able to catch up unless direct intervention in learning words is provided, (p. 206)."

While the research and the quantitative data were quite daunting, the qualitative data did look promising. With having understood that students from a low socioeconomic status arrive with a severely diminished lexicon, which ultimately, through a multilayered, multifaceted process, leads to a diminished comprehension had to be taken in context and perspective. There needed to be the understanding that there would not be much background knowledge for the students to access, there would be a diminished lexicon, and there would be severely compromised reading comprehension ability. With that understanding, there was an approach to develop the students' lexicon, to have multiple literacy opportunities provided, and to have literacy strategies incorporated into most if not all lessons.

Qualitative Data and Repercussions for Lexicon Development

Using the qualitative student data that showed interest and excitement around having this list of unknown or unfamiliar non-content vocabulary words made available to them on all assessments was an enormous step in the right direction. The hope was
that in providing the students access to these words and forcing them to use these words, these words would then be incorporated into their working lexicons. According to Alexander (2005), "Until we adopt a lifelong perspective (to reading), we continue to run the risk of turning out undeveloped, unmotivated, and uncritical readers unable to fulfill their responsibilities within a democratic society." (p. 413). Having captured a moment of interest and engagement in literacy, the students will have a larger, more developed and comprehensive lexicon, especially with tier two words, at the end of the school year than when they began. Even if the motivational factor for the students was that they were given the opportunity to use the non-content vocabulary list with definitions on their assessments, this allowed the students significant exposure and repetition to these commonly used tier two words and this hopefully will lead to this more developed and comprehensive lexicon which then could increase comprehension and understanding. The idea of being highly competent spoke to what the reader could do with the text in terms of comprehension, synthesis between texts, and deep understanding on the metacognitive level. This was the ultimate goal for all students.

Explanation for Ambiguity of Quantitative Data

In the science classroom, there was a multitude of strategies focused on learning of the tier three, or content specific words that were brand new to the students. Literacy was focused on the content vocabulary and content reading. There was little time spent focusing on non-content vocabulary. There was also either an assumption of prior knowledge or ignorance to the lack of prior knowledge of the necessary tier two, non-content vocabulary words that were necessary to have incorporated within the students' lexicon in order for them to be successful. A common agreement among the research has
been that repetition is a crucial factor of the incorporation of the new vocabulary word into the students' lexicon. According to Spencer & Guillaume (2006), The richer and more varied students' experiences related to particular concepts, the more finely detailed and nuanced their understanding of related terms can be expected to be.” (p. 208).

The lack of focus and repetition employed on these commonly occurring non-content vocabulary words could account for the ambiguity in the qualitative data. If there were a concerted, focused effort embedded within the curriculum to focus on these targeted non-content vocabulary words that seemed to impede the success of students in a secondary science classroom, then these words would be incorporated into the students' lexicons and then the students would better comprehend the questions and would begin to make connections to their content knowledge and be better prepared to be successful.

The opportunity that was provided to the students to utilize the targeted non-content vocabulary list on all assessments will give them the repetition to incorporate the words into their working lexicons. Also, having the words used frequently in class discussion will provide students with other rich opportunities for repetition and incorporation of the vocabulary words into their lexicons. The repetition needs to happen in multiple contexts, at different times, express the multidimensionality of the word, and the students' themselves need to be required to use the word in their daily activities in class.

The literature discussed the need for a multifaceted approach to vocabulary development with multiple encounters with the words and the opportunity to use them. The students needed to be immersed in the language through all facets of literacy, reading, writing, listening, and speaking. (Beck et al., 2002; Graves, 2007).
Conclusion

Being a scientist and only having had conducted scientific research, the importance of qualitative data in educational research was definitely an enormous insight gained through the research process. Another enormous insight gained through the research process was ambiguity of quantitative data when working with human subjects in an arena such as education. Having worked everyday with approximately seventy kids from seventy different backgrounds with seventy different home lives that have had seventy different daily experiences before they have walked into the classroom to learn science leaves a multitude of error in pure quantitative data. Also, having attempted to isolate one variable in order to conduct a valid study was almost impossible to do in an absolute sense. Thus, the interpretation of the pure quantitative data that was collected in this study without incorporating and accounting for the qualitative data did not provide an accurate view of what the students knew and were able to do, and thus could have led to false conclusions.

The need for content teachers to spend time with commonly occurring, tier two, non-content vocabulary words and allow learning opportunities for the students would be highly beneficial. Providing repetition and contextual learning opportunities within the classroom for non-content vocabulary that tends to impede student success has the potential to greatly increase reading comprehension, understanding of content specific concepts, as well as ultimately leading to greater success of the students.

Recommendations for future research is for content teachers to spend time developing lists of commonly occurring tier two non-content words that students typically struggle with understanding. Then, develop avenues within the content
curriculum to incorporate teaching of, repetition, and strategies for this targeted vocabulary development. Another recommendation would be to communicate vertically within disciplines at all levels to develop common language for non-content vocabulary that the students will eventually have to know. Keeping in mind the aforementioned lifelong approach to developing good readers, the quantitative data should eventually catch up with the preliminary qualitative data.
References


Table 1

*Comparison of Average Score on New York State Regents Living Environment Assessments with a Non-Content Vocabulary Focus*

<table>
<thead>
<tr>
<th>Class</th>
<th>Average Score Using Non-Content Vocabulary List</th>
<th>Average Score Not Using Non-Content Vocabulary List</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class A</td>
<td>66.8%</td>
<td>64.1%</td>
</tr>
<tr>
<td>Class B</td>
<td>52.9%</td>
<td>60.0%</td>
</tr>
<tr>
<td>Class C</td>
<td>57.6%</td>
<td>54.0%</td>
</tr>
</tbody>
</table>
Figure 1. Overall Non-Content Vocabulary Comparative Assessment
Appendix B

Unknown Vocabulary Search

Non-Content Vocabulary Identification
Unknown Word Search
Living Environment
Mr. Fuller

Directions: This is your UNIT TEST. Please go through every question and write any word that you do NOT know on this list.
Appendix C

Unknown Vocabulary Categorization

Non-Content Vocabulary Identification
Unknown Word Categorization
Living Environment
Mr. Fuller

Directions: Now that you have identified ALL of the words in your assessment that you don't know...we now need to categorize the words into Content-Related (Science) Words (that we will learn about in this unit), and Non-Content Related (Non-Science) Words (that we will focus on for this activity).

<table>
<thead>
<tr>
<th>CONTENT-RELATED (SCIENCE) Words</th>
<th>NON-CONTENT RELATED (NON-SCIENCE) Words</th>
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## Identified Non-Content Vocabulary

<table>
<thead>
<tr>
<th>N-C Vocabulary Word</th>
<th>Definition/Description</th>
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<tbody>
<tr>
<td>Absent</td>
<td>Not there, missing</td>
</tr>
<tr>
<td>Acceptable</td>
<td>Okay, able to do, satisfactory</td>
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<tr>
<td>Activated</td>
<td>Turned on</td>
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<tr>
<td>Affect</td>
<td>To act physically on</td>
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<tr>
<td>Alterations</td>
<td>Changes</td>
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<tr>
<td>Analyze</td>
<td>Consider in detail</td>
</tr>
<tr>
<td>Appearance</td>
<td>What something looks like</td>
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<tr>
<td>Barriers</td>
<td>Things that stop or prevent</td>
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<tr>
<td>Characterize</td>
<td>Describe, give qualities to</td>
</tr>
<tr>
<td>Compare</td>
<td>Consider and describe similarities and differences</td>
</tr>
<tr>
<td>Complexity</td>
<td>Opposite of simple, lots of qualities</td>
</tr>
<tr>
<td>Composed of</td>
<td>Made up of</td>
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<tr>
<td>Contributes</td>
<td>Adds to, helps</td>
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<tr>
<td>Converts</td>
<td>Changes</td>
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<tr>
<td>Cooperative</td>
<td>Helpful</td>
</tr>
<tr>
<td>Decrease</td>
<td>Make smaller or go down</td>
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<tr>
<td>Demand</td>
<td>Need</td>
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<tr>
<td>Depletion</td>
<td>Amount of something is going down or decreasing</td>
</tr>
<tr>
<td>Describe</td>
<td>Give a representation in words</td>
</tr>
<tr>
<td>Determine</td>
<td>Decide, make a conclusion</td>
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<tr>
<td>Directly</td>
<td>Affected by, relationship, resulting from</td>
</tr>
<tr>
<td>Duplicate</td>
<td>Make a copy of</td>
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<tr>
<td>Effect</td>
<td>The outcome or result</td>
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<tr>
<td>Eliminate</td>
<td>Get rid of</td>
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<tr>
<td>Excessive</td>
<td>A lot of</td>
</tr>
<tr>
<td>Extended to</td>
<td>Including</td>
</tr>
<tr>
<td>Function</td>
<td>The job that something does</td>
</tr>
<tr>
<td>Illustrate</td>
<td>To draw in pictures or diagrams</td>
</tr>
<tr>
<td>Implementing</td>
<td>To put into effect, to start something</td>
</tr>
<tr>
<td>Increase</td>
<td>To make larger or go up</td>
</tr>
<tr>
<td>Indicates</td>
<td>A signal or a symptom of</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Indirectly</td>
<td>Affects somewhat, but not because of</td>
</tr>
<tr>
<td>Inferred</td>
<td>Believe to be true, conclude, guess</td>
</tr>
<tr>
<td>Influences</td>
<td>Act upon, shape, cause</td>
</tr>
<tr>
<td>Interfered</td>
<td>To stop or block something</td>
</tr>
<tr>
<td>Invalid</td>
<td>Not true</td>
</tr>
<tr>
<td>Irreversible</td>
<td>Cannot be changed</td>
</tr>
<tr>
<td>Maintain</td>
<td>To keep up, hold, sustain</td>
</tr>
<tr>
<td>Matures</td>
<td>To develop or get older</td>
</tr>
<tr>
<td>Modify</td>
<td>To change</td>
</tr>
<tr>
<td>Obtain</td>
<td>To get something</td>
</tr>
<tr>
<td>Organization</td>
<td>Structured or having order</td>
</tr>
<tr>
<td>Pattern</td>
<td>Arrangement, how something is put together</td>
</tr>
<tr>
<td>Predict</td>
<td>Tell in advance, anticipate</td>
</tr>
<tr>
<td>Present</td>
<td>Existing now, is in a specific place</td>
</tr>
<tr>
<td>Principle</td>
<td>Most important</td>
</tr>
<tr>
<td>Produce</td>
<td>To make or create</td>
</tr>
<tr>
<td>Reduction</td>
<td>To have less of</td>
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<tr>
<td>Regarding</td>
<td>Paying attention to</td>
</tr>
<tr>
<td>Related to</td>
<td>Being connected to</td>
</tr>
<tr>
<td>Relative</td>
<td>Having to do with, connected to</td>
</tr>
<tr>
<td>Represents</td>
<td>To stand for or symbolize</td>
</tr>
<tr>
<td>Result</td>
<td>The outcome or solution</td>
</tr>
<tr>
<td>Sequence</td>
<td>The arrangement or order</td>
</tr>
<tr>
<td>Stabilize</td>
<td>To balance</td>
</tr>
<tr>
<td>Suppress</td>
<td>To slow down, to stop, to get rid of</td>
</tr>
<tr>
<td>Transport</td>
<td>Movement</td>
</tr>
<tr>
<td>Valid</td>
<td>Acceptable and supported by evidence</td>
</tr>
<tr>
<td>Variability</td>
<td>Differences</td>
</tr>
</tbody>
</table>
Appendix E

Regents Assessment A

Living Environment
Assessment A

One reason there was a shortage of producers in a food web is that:
1. Producers are not as important as consumers in a food web.
2. More consumers than producers are needed to support the food web.
3. Organisms in the food web are interdependent.
4. Populations tend to stay constant in a food web.

Which sequence shows a decreasing level of complexity?
1. organelle → organelle → cells → tissue
2. organelle → cells → organ → system
3. organelle → organ → tissue → cells
4. organelle → tissue → organ → system

State three factors that characteristic a forest ecosystem include:
1. Light and temperature
2. Availability of water
3. Types of producers and decomposers
4. Pits and number of heterotrophs

Many businesses choose to collect yard and street food waste and make compost, which can then be used to enrich the soil and improve soil quality.

A pattern of reproduction and growth of a controlled organism is shown below.

Which concept is best represented in the diagram shown below?
1. Human actions are a threat to equilibrium in ecosystems.
2. Equilibrium in ecosystems requires that humans modify ecosystems.
3. Equilibrium in ecosystems does not affect how humans modify ecosystems.
4. Human population growth is the primary source for equilibrium in ecosystems.

The size of a large population is more affected by:
1. Decreasing competition
2. Environmental factors
3. Decrease in food supply
4. The depth of water

The use of a large population is a period of severe ram for the following reason because:
1. The average speed of the species is too slow.
2. The average speed of the species is too fast.
3. The average speed of the species is too high.
4. The average speed of the species is too low.

Name:____________________

Which statement best describes the pattern of reproduction?
1. All genetic material comes from one parent.
2. Each sex of the genetic material comes from one parent.
3. The sex of the parent determines the sex of the genetic material.
4. The sex of the parent determines the sex of the genetic material.
Honeybees have a very cooperative way of living. Scout bees find food, return to the hive, and do the "waggle dance" to communicate the location of the food source to other bees in the hive. The waggle, represented by the wavy line in the diagram below, indicates the direction of the food source, while the speed of the dance indicates the distance to the food. Different species of honeybees use the same basic dance pattern in slightly different ways as shown in the table below.

<table>
<thead>
<tr>
<th>Number of Waggle Runs in 15 Seconds</th>
<th>Distance to Food (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Giant Honeybee</td>
<td>Indian Honeybee</td>
</tr>
<tr>
<td>10.6</td>
<td>10.6</td>
</tr>
<tr>
<td>9.8</td>
<td>8.3</td>
</tr>
<tr>
<td>6.7</td>
<td>4.4</td>
</tr>
<tr>
<td>4.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

47. State the relationship between the distance to the food source and the number of waggle runs in 15 seconds. [4]

48. Explain how waggle-dance behavior increases the reproductive success of the bees. [4]

49. The number of waggle runs in 15 seconds for each of these species is most likely due to:

1. Behavioral adaptation as a result of natural selection
2. Replacement of one species by another as a result of succession
3. Alterations in gene structure as a result of diet
4. Learned behaviors inherited as a result of sexual reproduction
Arsonic and Old Glucocorticoids

Constant exposure to small amounts of arsenic in drinking water has been found to increase the risk of cancer and other diseases. In January of 2001, the EPA (Environmental Protection Agency) lowered the acceptable levels of arsenic in drinking water from 50 ppb parts per billion to 10 ppb.

Researchers are now trying to determine how arsenic affects the body. Recent experiments suggest that arsenic may block the activity of hormones. One group of hormones affected by arsenic is glucocorticoids, which are responsible for activating many genes that appear to suppress cancer.

Both tumor cells were used to determine the effect of arsenic on glucocorticoids. One group of cells was treated with a solution of synthetic glucocorticoid and arsenic, another with a solution of synthetic glucocorticoid and water, and a third group with a solution containing only water. Researchers then measured the activity of one of the genes that is usually activated by glucocorticoids. The genes in the cells treated with the hormone and arsenic mixture and those treated with just water did not become activated. The genes in the cells treated with the hormone and water mixture were activated. Researchers concluded that arsenic blocked the normal activity of the hormone. They are now extending their studies to determine if arsenic acts in a similar manner in other types of cells and in entire organisms.

46. Research suggests that a buildup of arsenic in the cells of humans may be harmful because:

1) synthetic arsenic can be formed by the breakdown of glucocorticoid in the body
2) arsenic prevents the action of genes that are important in reactions that suppress cancer
3) arsenic prevents the action in which water and hormones bond and attach to cancer cells
4) glucocorticoid can build up in tissues and cause an increase in the absorption of arsenic

47. State one reason this study should be extended to other cells or to other complex organisms. [1]
Appendix G

Regents Assessment C

Living Environment
Assessment C

Which of the starch stored in the cells of a potato is composed of molecules that originally absorbed these cells
1. carbon
2. simple sugars
3. amino acids
4. minerals

Which diagram best illustrates an event in sexual reproduction that would most directly lead to the formation of a human embryo?
1. diagram (a)
2. diagram (b)
3. diagram (c)
4. diagram (d)

Which order of metabolic processes occurs in humans concerned by an organism into cell parts?
1. digestion → absorption → circulation → diffusion → excretion
2. absorption → circulation → digestion → diffusion → excretion
3. digestion → diffusion → circulation → absorption → excretion
4. absorption → digestion → diffusion → circulation

Which human activity would have the most positive effect on the environment at an area?
1. using fire to eliminate most plants in the area
2. clearing the area to eliminate non-native species
3. providing water fountains and grease in the area
4. introducing a new plant species to the area

What impact do the amounts of available energy, water, and oxygen have on an organism?
1. They are limiting factors.
2. They are used as nutrients.
3. They relate to the number of food organisms.
4. They control environmental conditions.

Which term would best represent X?
1. hormone
2. tissue
3. exoskeleton
4. organ

A science researcher is working on a project involving experiments and conclusions. The researcher would most likely consider the experiment successful if:
1. the sample size produced a great deal of data
2. other researchers were able to duplicate the results
3. a hypothesis was based and explained by the evidence given
4. the hypothesis was supported by the data obtained

Name: __________________________
The diagram below represents single-celled organisms A, B, and C. Cell A, B, and C all produce protein X. What can be inferred from this observation?

1. Protein X is found in all organisms.
2. The gene for protein X is found in single-celled organisms only.
3. Cells A, B, and C digested food containing the gene to produce protein X.
4. The gene for protein X can spread from cell A to cells B and C.

Many years ago, a volcano eruption killed most plants and animals on an island. Before the island became a desert, the population of a species of birds increased. Which statement best explains the increase in the population of birds?

1. A food source became available through the growth of new plant species.
2. Decreased competition resulted as a result of the process of co-evolution.
3. Geographic barriers prevent the migration of birds to distant habitats.
4. Decreased competition allows return to their original state.

The graph below shows how the human population has grown over the last several thousand years.

Growth of the Human Population

Number of People (billions)

0 1 2 3 4 5 6

Time (years)

4000 2000 1000 2000 5000 10000

Which statement is a valid inference that can be made of the human population over the past 10,000 years?

1. The rate of growth has remained constant.
2. The rate of growth has increased exponentially.
3. The rate of growth has decreased over time.
4. The rate of growth has accelerated over time.

A forest ecosystem will be cleared and many animal habitats may be destroyed. Which statement is true if global warming will decrease as a result of a lowered demand for fossil fuels?

1. Global warming will decrease as a result of a lowered demand for fossil fuels.
2. Global warming will increase as a result of increased greenhouse gas emissions.
3. Global warming will remain unchanged due to the balance of forces.
4. Global warming will increase due to increased deforestation.